SK361
.A257
No.62

LIBRARY
FISH & WILDLIFE SERVICE
PACIFIC OCEANIC FISHERY
INVESTIGATIONS

Special Scientific Report 62

A SURVEY OF THE COLUMBIA RIVER AND ITS TRIBUTARIES
with Special Reference to its Fishery Resources

2. Washington Streams from the mouth of the Columbia River to and including the Klickitat River (Area I)

By Floyd G. Bryant

UNITED STATES DEPARTMENT OF THE INTERIOR J. A. Krug, Secretary
Fish and Wildlife Service Albert M. Day, Director

Explanatory Note

The series, Special Scientific Reports, embodies results of investigations, usually of restricted scope, intended to aid or direct management or utilization practices and as guides for administrative or legislative action. It is issued in limited quantities for the official use of Federal, State or cooperating agencies and in processed form for economy and to avoid delay in publication.

Washington, D. C.
January 1949

United States Department of the Interior
J. A. Krug, Secretary
Fish and Wildlife Service
Albert M. Day, Director

Special Scientific Report No. 62

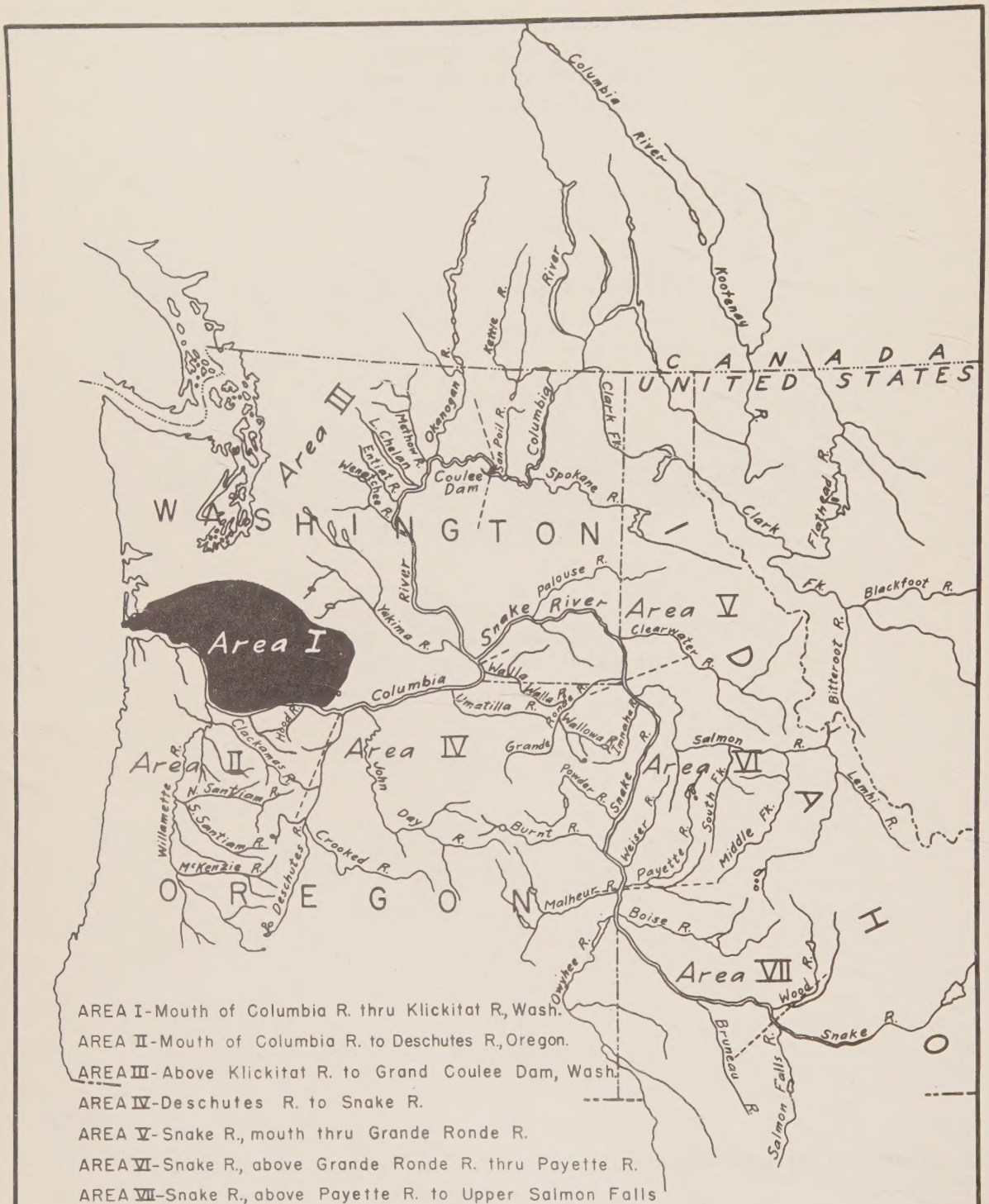
A SURVEY OF THE COLUMBIA RIVER AND ITS TRIBUTARIES WITH SPECIAL REFERENCE TO THE MANAGEMENT OF ITS FISHERY RESOURCES

2. Washington streams from the mouth of the Columbia River to and including the Klickitat River (Area I)

By Floyd G. Bryant, Aquatic Biologist
Branch of Fishery Biology

CONTENTS

	Page
Map of stream-survey areas ..... frontispiece	
Introduction	1
Part I, Area I, exclusive of Sub-area Cowlitz River	5
Part 2, Sub-area Cowlitz River	52
Literature cited	110



AREA I-Mouth of Columbia R. thru Klickitat R., Wash.
AREA II-Mouth of Columbia R. to Deschutes R., Oregon.
AREA III-Above Klickitat R. to Grand Coulee Dam, Wash.
AREA IV-Deschutes R. to Snake R.
AREA V-Snake R., mouth thru Grande Ronde R.
AREA VI-Snake R., above Grande Ronde R. thru Payette R.
AREA VII-Snake R., above Payette R. to Upper Salmon Falls

COLUMBIA RIVER SYSTEM

SCALE

40 20 0 50 100
50 30 10 25 75 125 MILES

Figure 1. Columbia River System

INTRODUCTION

The purpose of the Columbia River Stream Survey has been to provide data for the evaluation of each stream, or portion of stream, from the standpoint of its present and potential value in relation to the maintenance of the salmon resources of the Columbia River. A more complete statement of the purposes and methods of the survey is found in the general introduction to the stream survey series (Rich, 1948). The watershed has been divided into several survey areas as shown on the map preceding this page. This report covers Area I.

Area I includes all tributaries entering the Columbia River on the north, or Washington side, in the 180 miles from the mouth to and including the Klickitat River. The larger and more important salmon-producing streams include the Grays, Cowlitz, Kalama, Lewis, Washougal, Wind, Little White Salmon, White Salmon and the Klickitat rivers. The Cowlitz system is treated as a separate sub-area in Part 2 of this report.

Practically the entire drainage area lies in the belt of heavy rainfall west of the Cascades. It consists of rugged hills and mountains into which the streams have carved deep canyons and valleys. The complete watershed was originally covered with a dense coniferous forest which assured adequate water storage and maintained the flow in even the smaller streams throughout the dry summer and fall seasons. Consequently, salmon and trout in the past populated nearly every accessible stream, regardless of size, that provided even small areas of suitable spawning rubble.

With the coming of the white man the wider valley bottoms were cleared for farms, small towns appeared, and increasing numbers of salmon were taken for food, all of which resulted in a diminution of the abundance level of the salmon populations.

The lumbering industry, however, proved to be of major importance in the depletion of the salmon runs of this area. Logs and shingle bolts were flushed down the channels of the larger streams by "splash" dams. The masses of water and logs scoured the stream beds and removed the smaller rubble that is necessary for the construction of the spawning nests of all salmonoid fishes. The dams, having served their purpose, were abandoned, but were frequently left intact and continued to block the salmon from the upper portions of some of the streams. Logging waste was deposited in the stream channels and succeeding freshets often piled this into impassable barriers. Protective cover and marginal aquatic plants were destroyed and the capacity of the streams to produce food for young fish was diminished. The exposed hillsides were eroded by winter rains which quickly ran off instead of being held in the humus to be gradually released through the drier summer months. Sudden freshets scoured the stream beds for years after the loggers had left, and silt was deposited on otherwise suitable spawning areas making them no longer usable. The total effect was greatly to reduce the productivity of the streams with respect to anadromous fishes.

This area was completely logged off long ago with the exception of small remote areas and portions included in state and federal forest reserves and Indian reservations. Nature has been slow to replace the plant covering and man has aided only slightly by reforestation. Forest fires have impeded the recovery of the region. In 1902 a huge fire burned over part of the area and severe erosion still continues along many of the streams in the burned area. Run-off was speeded up so that streams that formerly had water sufficient for the ascent of salmon to their headwaters at any time of the year are now so low during the fall spawning season that only small portions are available.

Nevertheless, and in spite of the greatly reduced productivity, that portion of the Columbia River system that is included in Area I is important to any program committed to the rehabilitation and maintenance of the salmon resources. Practically every one of the tributary streams once supported salmon runs and it is reasonable to believe that, if properly aided by man, these can be made much more productive than at present. Most of the watershed now has a second growth cover of trees and brush that will increasingly check erosion and flood damage, replace humus, provide storage of the winter rains, and increase stream flows during the drier months. Unused splash dams or abandoned mill dams could be breached or removed and the streams cleared of log and debris jams. Many of the natural obstructions could be removed or made passable by the construction of fishways. Such improvements would greatly increase the value of the area for salmon production.

The rugged terrain of much of the area is not suited to farming and there will probably be few irrigation dams and ditches that might hinder the increase of the salmon runs. The area is favorable for salmon production because it is close to the mouth of the Columbia River so that the fish encounter fewer hazards during their migrations to and from the spawning areas than do the fish that pass to the more distant upper Columbia tributaries. Fewer power, irrigation, and flood control projects are contemplated for this area than are proposed for the upper main Columbia River and its tributaries.

The normal high water period in this area is from mid-December to May or June. Freshets during this time cause considerable fluctuation in water levels. Some of the tributaries of the Cowlitz show a variation in water level up to 25 feet in the narrower canyons, but this is exceptional. Steelhead trout reach the headwaters of many of the tributary streams during this period of high water which permits passage over many obstacles. During the period from July to early November the water is low, fluctuations in flow are usually slight, and spawning grounds in the upper portion of some of the streams are inaccessible. Fall rains occasionally raise the streams in October sufficiently to permit passage over some of the barriers.

Pollution from domestic waste is present in many streams, and while this condition is undesirable and potentially dangerous, it does not appear to be serious enough to affect fish in Area I under existing conditions. It should not, however, be allowed to increase. With few exceptions the towns in this area are small and the pollution is soon diluted. The main industrial pollution found in the area is the effluent from pulp mills, which is most extensive in the main Columbia River at and below the mouths of the Cowlitz and Washougal Rivers. (Lincoln & Foster, 1943).

In considering the value of streams for salmon production it is pertinent to recall that the various species and races seek somewhat different conditions for spawning. The blueback salmon spawns only in lakes or tributaries to lakes. There are no natural runs of this species in the streams of Area I at the present time.

Chum salmon seldom go more than 150 to 200 miles from the ocean to spawn. They usually make their first appearance in the Columbia River in October and proceed directly to the lower sections of the tributaries. This species is becoming more important to the commercial fishery as the other species are reduced in abundance and it is to be noted that Area I supports larger populations of chum salmon than does all the rest of the Columbia Basin combined.

There are only a few streams in Area I that still support good runs of spring chinook salmon. These fish enter the streams between February and late July but the main run appears in May or early June. They usually proceed up the larger streams to deep resting pools in the middle and upper sections of the tributaries where they remain until the approach of the spawning season in the fall. After the first fall rains they spread out over the spawning riffles but do not usually run into the shallow upper portions of the smaller streams.

The salmon stock in this area is composed primarily of fall chinooks. These fish enter the Columbia River from August to October and go directly to the spawning areas in the lower and middle sections of the tributaries.

Silver salmon are the second most abundant species of salmon in Area I. They occasionally appear in the Columbia by mid-August but usually are not present in large numbers before September. They spawn in nearly all of the middle and upper portions of the tributaries and may be found on small gravel patches at the mouths of small streams that are seldom used by chinooks. Large numbers of silver salmon fingerlings may be found in eddies and shallow marginal channels after the water level has dropped in late spring or early summer. More silver salmon are produced in this area than in all the rest of the Columbia River areas.

Steelhead trout enter the Columbia River during all months of the year, but the largest number pass through the lower river in July and August. They go as far up the streams as possible and, because their spawning migration occurs chiefly during the fall, winter, and early spring, when the water is high, they are often able to get above falls, dams, and debris jams that are impassable to the salmon.

Practically all of the streams of Area I that are believed to be of present importance in the maintenance of the runs of salmon and steelhead trout have been surveyed. Even the smaller tributaries have been included because most of them make some contribution, however small, to the fishery, and collectively their production is of considerable importance. This is especially true in view of the fact that in recent years the mainstay of the commercial fishery has been the summer and fall run fish. It is therefore of importance that all productive areas, no matter how small, be known so that they can be preserved and improved as rapidly as proper management by scientific methods allows.

It should again be emphasized that the estimates of spawning areas and of stream capacity are minimal; that the actual capacity for the spawning and rearing of salmon is probably considerably higher than given. The streams could not all be examined at the peak of the spawning activity, nor at the same season, so that the estimates are subject to some error and are not strictly comparable. The determination of the number of fish now actually using the streams therefore is only approximate.

Various individuals took part in the field work and, so far as possible, the names of those who were responsible for the observations recorded herein are given in connection with the treatment of each stream. The dates on which the observations were made are also given. For convenience the complete list of those taking part in the survey of Area I is given herewith: Charles H. Baltzo, Willard O. Brewington, Floyd G. Bryant, Clifford J. Burner, David G. Frey, Leonard A. Fulton, Harold A. Gangmark, Mitchell G. Hanavan, Frank W. Jobes, Lawrence N. Kolloen, Milton C. Lobell, William M. Morton, Zell E. Parkhurst, Richard F. Shuman, Arnie J. Suomela, Richard T. Whiteleather, and Paul D. Zimmer.

PART I

AREA I EXCLUSIVE OF SUB-AREA COWLITZ RIVER

CONTENTS

		Page
Map of Area I	opposite	4
List of streams		5
The survey		11
Description of streams		11
Obstructions and diversions		44

Figure 2. Stream Survey Areas I and II

Digitized by the Internet Archive
in 2025

https://archive.org/details/special-scientific-report-fish-and-wildlife-service_1949_62

LIST OF STREAMS 1/

	Page
1. Walicut River	11
2. Chinook Creek	11
3. Deep River	12
4. Grays River	12
A. Seal River	13
B. Malone Creek	13
C. Hull Creek	13
D. East Fork of Grays River (or Pearl Creek	13
E. Fossil Creek	13
F. Left Fork of Grays River	13
G. North Fork of Grays River	13
(1) Mitchell Creek	13
a. (unnamed tributary)	15
b. Left Fork of Mitchell Creek	15
(2) Johnson Creek	15
H. South Fork of Grays River	15
(1) Blaney Creek	15
5. Crooked Creek	16
6. Jim Crow Creek	16
A. West Fork of Jim Crow Creek	16
7. Skamokawa Creek	16
A. Rice (or Alger) Creek	17
B. West (Valley) Fork	17
C. Wilson (or Willow) Creek	17
(1) Elkhorn Creek	17
D. Middle Valley Fork	17
8. Alochomin (or Elochoman) River	17
A. Beaver Creek	18
B. Duck Creek	18
C. West Fork of the Alochomin River	18
D. East Fork of the Alochomin River	19
(1) Left Branch of the East Fork	19
*(2) Right Branch of the East Fork	

1/ Those streams marked with an asterisk are unsurveyed minor tributaries with a barrier or fluctuating flow. They are not described in the text but are retained for check list purposes.

Page

9. Birnie Creek 19
10. Abe Creek 19
11. Mill Creek 19

A. Little Mill Creek 20

12. Abernathy Creek 20

A. Cameron Creek 20

13. Germany Creek 21
14. Falls Creek 21
15. Coal Creek 21

A. Mosquito Creek 21

16. Clark Creek 21
17. Cowlitz River (See Part II) 22
18. Owl Creek 22
19. Fish Pond Creek 22
20. Kalama River * 22

A. Little Kalama River 23
B. Rock (or Gobar) Creek 23

(1) Bear Creek 23

21. (Unnamed Creek) 23
22. (Unnamed Creek) 23
23. Rock Creek 23
24. Speelyai Creek 23
25. Burris Creek 23
26. Lewis River 23

A. East Fork of Lewis River 24

(1) Lockwood Creek 25
(2) Bee Tree (?) Creek 25
(3) Lower Rock (?) Creek 25
(4) Big Tree Creek 25
(5) Rock Creek 25

a. Cedar Creek 26
b. Coyote Springs Creek 26
c. Grouse Creek 26

*(Kalama River and tributaries above Rock Creek not surveyed.)

Page

(6) King Creek 26
(7) Copper Creek 26

a. Star Creek 26
b. Summit Creek 26
c. Miners Creek 26

(8) Slide Creek 26
(9) McKinley Creek 26
(10) Little Creek 26
(11) Green Fork 26

B. Cedar Creek 26

(1) John Creek 27
(2) Brush Creek 27
(3) Chalatche Creek 27

(All other tributaries of Lewis River are above Ariel Dam and as yet unsurveyed).

27. Salmon Creek 27

A. Whipple Creek 28
B. Mill Creek 28
*C. Unnamed Creek
*D. Morgan Creek

28. Washougal River 28

A. Lacamas Creek 30
B. Little Washougal River 30
(1) East Fork of Little Washougal River 30

a. Jones Creek 30

C. Canyon (or Cougar) Creek 30
D. West Fork of the Washougal River 30

(1) Texas Creek 31

* a. Wildboy Creek

E. McCloskey Creek 31
F. Dougan Creek 31
G. Stebbins Creek 31
H. Timber Creek 31

Page

I. Silver Creek 31
J. Prospector Creek 31
K. Meander Creek 31
L. Grouse Creek 31
M. Lookout Creek 31
N. Bear Creek 31

29. Gibbons Creek 32
30. Walton Creek 32
31. St. Cloud Creek 32
32. Duncan Creek 32
33. Woodward Creek 32
34. Hardy Creek 32
35. Hamilton Creek 32

A. Greenleaf Creek 32

36. Blue Lake Creek 32
37. Rock Creek 32
38. Nelson Creek 33
39. Carson Creek 33
40. Wind River 33

A. Little Wind River 34
B. Brush Creek 35
C. Bear Creek 35
D. Panther Creek 35

(1) Cedar (or Clear) Creek 35
* (2) Eight Mile Creek
* (3) Mouse Creek
* (4) Temmile Creek

E. Trout Creek 35

(1) Martha Creek 36

F. Hollis Creek 36
G. Cold Creek 36
H. Tyee Springs Creek 36
I. Trapper Creek 36
(1) Lost Creek 37
J. Dry Creek 37
K. Ninemile Creek 37
L. Falls Creek 37
M. Paradise Creek 37
N. Old Man Creek 37

41. Collins Creek..... 37

Page

42. Dog Creek 37
43. Little White Salmon River 37
44. Spring Creek 38
45. White Salmon River 39
46. Catherine Creek 39
47. Major Creek 39
48. Klickitat River 39

A. Silvia (or Silvies) Creek 40
B. Dillacort Canyon Creek 40
C. Moore Canyon Creek 40
D. Swale Canyon Creek 40
E. Little Klickitat Creek or River 41

(1) Bowman Creek 41

* a. Canyon Creek

(2) Mill Creek 41
(3) Spring Creek 41

F. Dead Canyon Creek 41
G. Summit Creek 41

* (1) Cedar Creek
* (2) Featherbed Creek

H. White Creek 41

* (1) Brush Creek

* a. Blue Creek

* (2) Tepee Creek

I. Outlet Creek 41

* (1) Frazier Creek

* a. Bird Creek

J. Elk Creek 42
K. Bear Creek 42

* (1) Trout Creek

L. Deer Creek 42

Page

M. Bacon Creek 42
N. Dairy Creek 42
O. Big Muddy Creek 42
(1) Cougar Creek 42
(2) Hellroaring Creek 42
(3) Rusk Creek .....

P. Cunningham Creek 42
Q. Surveyors Creek 42
R. Soda Spring Creek 42
S. West Fork of the Klickitat River 42

(1) Little Muddy Creek 42

* a. Clearwater Creek
* b. Crawford Creek

(2) Fish Lake Stream 42

* a. Two Lakes Creek

T. Swamp Creek 43
U. Chaparral Creek 43
V. Pearl Creek 43
W. East Fork of the Klickitat River 43

* (1) McCready Creek

X. Huckleberry Creek 43
Y. Piscoe Creek 43
Z. Diamond Fork 43

* (1) Maiden Creek
* (2) Cuitin Creek
* (3) Coyote Creek

THE SURVEY

In the investigation of this area survey crews examined 53 streams in detail and briefly inspected numerous small tributaries. These 53 streams have an aggregate length of 750 lineal miles, of which 346 miles were surveyed. In the sections surveyed, there are approximately 10,700,000 square yards of bottom of which 8,800,000 square yards are accessible at present. Some 1,900,000 square yards are above impassable barriers. It is estimated that there is presently available suitable spawning area sufficient for at least 140,000 salmon and that additional spawning area could be provided for 40,000 to 50,000 more if the streams were improved by removing minor barriers.

DESCRIPTION OF STREAMS

1. Walicut River: Lowermost of the streams entering the Columbia on the Washington side, this stream is merely a slough, has practically no suitable spawning area, and no salmon have been reported from it. It enters the Columbia approximately 2 miles above Ilwaco, Washington.

2. Chinook Creek: (May 17, 1946; Fulton and Zimmer.) Enters the Columbia River about 6 miles above the mouth and 3 miles below the town of Chinook, Washington. Its length is about 8 miles, the width 6 feet, its flow was estimated at 20 c.f.s., 1/ and the

---

1/ Throughout this series of reports the abbreviation "c.f.s." is used for "cubic feet per second".

temperature was 50° F. In the 1.7 miles surveyed above the slough there was spawning area for at least 500 pairs of salmon. Some salmon, notably silvers, occasionally spawn above the section of the stream that was surveyed. The lower 3 miles is a tidal slough in marshy pasture-land. The gradient of the remainder of the stream is generally low and there are no important tributaries. Tidal gates near the mouth prevent the entrance of fish on an incoming tide. There are many low beaver dams in the section surveyed; all appear to be passable at the present time although low water during the fall may make passage difficult for salmon. Some beaver dams in the upper portion of the stream are reported to be barriers. With all obstructions removed or made passable and with minor channelization in some low gradient sections, Chinook Creek could probably accommodate 1000 pairs of salmon.

One of the first salmon hatcheries in the Columbia Basin was located on Chinook Creek and operated for many years by the Washington State Department of Fisheries. Chiefly fall chinook salmon were propagated at this station. It is reported that the runs into the stream have dwindled since the hatchery was closed a number of years ago, but a few fall chinooks still enter the stream and fingerlings were observed by the field party. A run of silver salmon is reported to have ascended as far as a beaver dam barrier some 3 miles above the mouth in the fall of 1946.

3. Deep River: (June 12, 1942; Parkhurst. May 17, 1946; Gangmark) Enters the Columbia River in Gray's Bay, approximately 20 miles above the mouth. It is 8 miles long and the lower 5 miles consists of a deep tidal slough of no value to salmon. Just above the town of Deep River tidal gates across the slough bar the passage of fish during flood tide. Above the tidal gates the stream is too small to be of any real value, flowing only 1 to 2 c.f.s. A few resident trout and brook lampreys were observed in the one mile of stream surveyed above the slough.

4. Grays River: (Nov. 10 to 12, 1936 and May 19, 1937; Hanavan, Baltzo and Lobell. June 7, 1937, Baltzo and Lobell.) Grays River is 16 miles long and enters the Columbia River 21 miles above the mouth. The lower 6 miles is a slough of no value to salmon. The next 6 miles flows through a flat, pastured valley where the stream is from 50 to 140 feet wide and has many excellent spawning riffles. Calculated flows were: 43 c.f.s., Nov. 12, 1936; 61 c.f.s., May 19, 1937; and 121 c.f.s., Oct. 4, 1945. There was evidence of a 3-foot fluctuation in water level. Water temperatures were: 52° F., Nov. 12, 1936; 48° F., May 9, 1937; 54° F., June 7, 1937, and 54° F. Oct. 4, 1945.

For four miles below the confluence with the North and South Forks the stream lies in a deep canyon between high, forested and partially logged-off hills. In this canyon section at approximately 13 miles above the mouth and 7 to 8 miles above tide water, a difficult 8-foot cascade or falls is located, with a second higher falls located just above it. These falls are a complete barrier to all salmon, but in some high water seasons steelhead manage to go above them. In other seasons, with smaller spring freshets, most steelhead are apparently blocked at this point. Mr. Ward Holloway of Cathlamet who has fished the stream for many years reports that in 1945 and again in 1946 there were several hundred steelhead lying in the pools between or just below the falls in early May that had been unable to reach the spawning grounds above the falls. These falls and several debris jams should be either removed or a passage-way provided so that salmon and steelhead may pass them at all water stages and be able to reach the extensive spawning grounds in the upper Grays River and its tributaries.

There is spawning area for at least 3500 pairs of salmon between the slough and the falls, and sufficient for 700 more pairs above the falls to the junction of the North and South Forks. There is a large run of chum salmon into the river and 6,286 spawning or spawned out chums were counted below the falls on November 11, 1936, when the water was low. A small run of silver salmon is reported to spawn below the falls in October. Some fall chinooks are also present, field men of the Washington State Fisheries Department having counted 34 chinooks on October 3, 1944, 10 on October 5, 1945, and 3 on October 22, 1945. A good run of steelhead passes through the main river in early spring to spawn chiefly in the upper tributaries. In May and June, 1937, 14 late spawning steelhead were counted below the falls. Rainbow and cutthroat trout are caught in the upper river and its tributaries.

4A. Seal River: A small stream entering Grays River 2 miles above the mouth. It was not surveyed.

4B. Malone Creek: Enters Grays River 4 miles above the mouth. It is 4 miles long and has not been surveyed.

4C. Hull Creek: (Inspected June 12, 1942; Parkhurst.) Enters Grays River 8 miles above the mouth and is about 7 miles long. Its flow at the highway bridge was estimated at 15 c.f.s., and the temperature was 51° F. The stream is in a lowland valley, and only about 30 percent of the bottom was considered to be suitable for spawning. A few chum and silver salmon are reported to enter this stream.

4D. East Fork: (Nov. 10, 1936; Hanavan, Baltzo and Lobell.) A small creek, sometimes known as Pearl Creek, that enters Grays River 10 1/2 miles above the mouth. Its flow was less than 1 c.f.s. The bottom is nearly all mud and the stream has no value for salmon spawning.

4E. Fossil Creek: (Inspected November 10, 1936; Hanavan.) This stream enters Grays River 12 miles above the mouth, is approximately 5 miles long, and has only a small flow. Some good spawning areas were observed, however, and a few chum salmon are reported to enter. This stream has not been surveyed.

4F. Left Fork: (November 11, 1936; Hanavan, Baltzo and Lobell.) This tributary enters Grays River approximately 12 miles above the mouth. It is several miles long and was surveyed for 3.2 miles, at which point the stream was so clogged by logging debris that it was impassable to fish. Logging operations were still being conducted. The valley is narrow, and is flanked by rolling hills but the gradient is moderate. The stream is 20 to 40 feet wide, and had a low flow of only 9 c.f.s. when visited, with about half of the stream bed exposed. The water temperature was 47° F. It was estimated that there was spawning area for the accommodation of at least 750 pairs of salmon, nearly all of which was actually in use. A count of 1,388 chums and 105 silver salmon was made. Although there are no tributaries of importance, it is obvious that, when logging operations are completed on the watershed, all of the debris jams and logging waste should be removed or made passable, and the remainder of the stream should be surveyed.

4G. North Fork: (June 11 and 12, 1937; Hanavan, Baltzo, and Lobell.) The North Fork flows 10 1/2 miles from its source in high, densely forested hills to its confluence with the South Fork to form the main Grays River. The lower 5.7 miles were surveyed to the confluence of Johnson Creek.

The valley of the North Fork is deep and narrow for its entire length and the marginal undergrowth is extremely heavy. The upper portion surveyed was in a deep box canyon. The stream is 30 feet wide and 15 1/2 inches in depth at the mouth, and is 21 feet wide and averages 10 inches deep near the point where the survey was discontinued. The flow was estimated to be 30 to 35 c.f.s. at the mouth and 15 c.f.s. just above the mouth of Mitchell Creek, 3.7 miles upstream. Fluctuations in water level of 10 to 15 feet are indicated near Mitchell Creek and in some of the narrow canyons above. The gradient was estimated to be 80 to 100 feet per mile and resting pools average 17 per mile. The water temperature on June 12, 1937 was 54.5° F. at the mouth and 52° F. at the confluence with Mitchell Creek. No pollution was noted. Approximately 5 miles above the junction with the South Fork there is an old 18-foot splash dam that forms a total barrier to the passage of fish. There is suitable spawning area for at least 1,100 pairs of salmon below the dam and more above it. Salmon do not spawn in the North Fork at present, apparently because the falls on the main Grays River block their ascent. However, in seasons when water conditions permit passage of steelhead over the Grays River Falls, good runs of early spring steelhead spawn in the North Fork up to the impassable dam. Many redds were seen, and 6 fish were observed by the survey party. Spawning is apparently completed by late May or early June, but the spawning grounds are far from being fully utilized. There are also large resident rainbow and cutthroat trout in the stream. This stream could be greatly improved by the removal of the splash dam, which has not been used for some time. Salmon stocking appears feasible if passage is provided over the falls in the lower Grays River.

4G-(1) Mitchell Creek: (June 11, 1937; Lobell.) This is the largest tributary to the North Fork of Grays River. It enters the North Fork 3.7 miles above the mouth, is 6 miles long, and branches about a mile above the North Fork. The lower 2.7 miles were surveyed. Mitchell Creek has a watershed of high, heavily-forested hills. Its banks are generally steep and the marginal vegetation dense. At the mouth it is 50 feet wide and averages 6 inches in depth with an estimated flow of 18 c.f.s. Where the survey was discontinued it was 10 feet wide, averaged 9 inches in depth, and had a flow of about 8 to 10 c.f.s. The water temperature was 51° F. The gradient is moderate throughout with some small cascades. Fluctuations in water level were generally about 5 feet, but were higher in restricted canyon areas. There were no dams, diversions or pollution in the area surveyed. There are two falls; one 6 feet high located 1,800 yards above the mouth, and another 7 feet high located 1,900 yards above the mouth, both difficult for fish to pass. There is suitable spawning area present for several hundred fish. As in the North Fork, no salmon runs occur, but a run of spring steelhead spawns in the stream and 5 late spawners were seen by the survey party. Rainbow and cutthroat trout are numerous.

4G-(1)a Unnamed tributary: (June 11, 1937; Lobell.) Enters Mitchell Creek approximately 100 yards above the mouth. Its width was 18 feet, its average depth 6 inches, and its flow 6-8 c.f.s. There was an impassable log jam 40 feet high located about a mile above the mouth. Due to the steep gradient, the stream has many cascades and suitable spawning rubble is scarce and scattered. The stream is of little importance, although it is utilized by steelhead, since a few late spawners were observed.

4G-(1)b Left Fork of Mitchell Creek: (June 11, 1937; Lobell.) Enters Mitchell Creek about 1,300 yards above the mouth. It was inspected for 600 yards above the mouth, where there was a brush jam that was probably passable for fish. The width of the creek was 8 feet, its average depth 4 inches, the flow was 6-8 c.f.s. and the gradient was moderate. About 20 percent of the bottom was considered to be suitable for spawning. No steelhead were observed.

4G-(2) Johnson Creek: (June 11, 1937; Hanavan.) Enters the North Fork 5.7 miles above the mouth, and since its flow was less than 10 c.f.s. it was not surveyed in detail.

4H. South Fork of Grays River: (June 8, 1937; Hanavan, Baltzo, and Lobell.) Its length is 8 miles, its flow 18 c.f.s, the temperature 51° F, and the water level fluctuates from 10 to 20 feet in the canyons. The drainage area is densely wooded, with the surrounding hills and ridges rising to 1,500 or 1,600 feet. An abandoned splash dam 40 feet in height is located 260 yards above the mouth. Logs and debris fill the forebay and at low water periods there is no spill over the dam, as all the water then seeps between the logs. Removal of the dam would be costly and fish ladder construction difficult. From the mouth to the dam there is little or no suitable spawning rubble. Some favorable areas are located in the first half-mile inspected above the dam, but the large rubble content increases for the next 3 miles, at which point there is an impassable 15 foot falls. Cutthroat trout are found above the dam in considerable numbers. The South Fork has no run of salmon or steelhead, and the stream is valueless to these species until the dam is breached or removed.

4H-(1) Blaney Creek: (June 8, 1937; Baltzo.) This small creek, approximately 6 miles long, enters the South Fork about 1/2 mile above the mouth and had a flow of about 4 c.f.s. The lower 3 miles has a moderate gradient with numerous well-protected pools and excellent spawning areas throughout. In the upper section the stream flows through canyons and is much steeper, although it rises in a large, flat, plateau-like area. It is inaccessible at present to salmon and steelhead because of the dam on the South Fork.

5. Crooked Creek: (May 19, 1937; Lobell. May 20, 1946; Zimmer and Brewington.) This 8 mile long creek enters the Columbia River 1 mile above Grays River. The lower portion is a tidal slouth, above which the stream was surveyed for a distance of 4 miles, including 2 miles of the North Fork. Its width is 6 to 30 feet and its flow was 20 c.f.s., but is estimated to be only 3-4 c.f.s. during the dry season. Its temperature was 50°-53° F. The main stream is formed by the junction of two forks about 2.5 miles above the tidal slough. Just below this junction there is an irrigation dam, 4 feet high, that forms a low water barrier. About 2 c.f.s. are diverted by this dam and there are no fish protective devices. An old unused power dam located 600 yards up the North Fork should be removed. It is estimated that there is spawning area in the main stream for about 200 pairs of salmon and sufficient for 100 additional pairs above the old dam on the North Fork. Salmon fingerlings were observed but the species was not determined. Four steelhead redds were noted in the North Fork below the dam. Sea-run cutthroat enter the creek in October and November.

6. Jim Crow Creek: (May 19, 1937; Hanavan and Lobell. May 21, 1946; Brewington.) Enters at Brookfield, Wn., approximately 30 miles above the mouth of the Columbia River. Its length is 6 miles, its width 4-12 feet, its flow was 10-12 c.f.s. in May, 1946, and the temperature was 49-52° F. The lower mile or so is a tidal slough. The stream is spring fed, and has no obstructions or diversions, except an occasional brush jam that could easily be removed. Spawning area was estimated to be sufficient for about 200 pairs of salmon. Many unidentified salmon fingerlings were seen and while it is reported that silver salmon, chum salmon, and steelhead spawn in the stream, this should be checked during the spawning seasons.

6A. West Fork of Jim Crow Creek: (May 19, 1937; Lobell.) This is a small tributary entering near the mouth of Jim Crow Creek. The flow was approximately 2 c.f.s., the gradient is moderate, and there is a large amount of mud and sand between small spawning riffles. Silver salmon fry and fingerlings were observed, though the stream is relatively unimportant.

7. Skamokawa Creek: (May 22 and 23, 1946; Zimmer and Brewington.) Enters the Columbia River 34 miles above the mouth. The lower part is a tidal slough. The length above the slough is 7 miles, the width 9-36 feet, the flow 10-25 c.f.s., and the temperature was 50°-52° F. The survey covered the first 4.3 miles above the slough. It was estimated that this portion of the stream would provide suitable spawning area for at least 1200 pairs of salmon. Many salmon fingerlings were observed, especially in the upper 2 miles, some of which were silver salmon. Steelhead trout were observed, suckers (Catostomus Sp.) were plentiful in the lower 2.5 miles, and chum salmon have been reported.

7A. Rice Creek: Also known as Alger Creek. This is a small stream entering the Skamokawa slough near the town of Skamokawa. It is of no appreciable value to salmon.

7B. West Fork: (November 11, 1936; Hanavan and Whiteleather.) Also known as West Valley Creek. This is a small creek that enters Skamokawa Slough below the high tide mark. The bottom is muddy and there are no salmon runs. A few sea-run cutthroat are reported.

7C. Wilson Creek; Also known as Willow Creek: (Nov. 11, 1936; Hanavan and Whiteleather. May 22 and 23, 1946; Zimmer and Brewington.) Enters Skamokawa Slough about 1 mile above the mouth near the head of tidewater. Of a total length of 7.5 miles, 5.6 miles were surveyed. Its width was 6-21 feet, its flow 10-20 c.f.s., and the temperature 50-52° F. A log and brush jam 4.3 miles above the slough is nearly impassable. It was estimated that the stream provided suitable spawning area for at least 600 pairs of salmon. Chum salmon were observed spawning in November and steelhead redds were observed in May. A small run of silver salmon is also reported.

7C-(1) Elkhorn Creek: (May 22 and 23, 1946; Zimmer and Brewington.) This is the chief tributary to Wilson Creek, entering 5 miles above the mouth through a culvert 40 feet long. Local residents state that this culvert has interfered with the migration of chum and silver salmon that formerly entered Elkhorn Creek. The flow was about 3 c.f.s., indicating that the stream would now accommodate only a few salmon. Passage through the culvert could be improved by the installation of baffles.

7D. Middle Valley Fork: (Nov. 11, 1936; Hanavan and Whiteleather. May 22, 1946; Zimmer.) Also known as Standard Creek. Enters Skamokawa Creek through two mouths about 3 miles above the confluence with the Columbia River. Its length is 6 miles, its width 15 feet, and the flow was 30 c.f.s. in May and 8 c.f.s. in November. The temperature in May was 51° F. Near the mouth the gradient is slight and the bottom is chiefly sand, but higher up there is suitable spawning area for several hundred salmon. The indications are that a fair run of steelhead enters the creek. Small salmon fingerlings were numerous and it was reported that silver and chum salmon spawn in this stream during the fall.

8. Alochomin River: (December 4 to 7, 1935; Shuman and Whiteleather. November 5, 1936, and May 20, 1937; Hanavan, Baltzo, and Lobell.) Also known as the Elochoman River. This stream enters the Columbia River 38 miles above the mouth, just below the town of Cathlamet, Washington. The length to the confluence of the East and West Forks is 15 miles, all of which was surveyed. The width is 175 feet at the mouth and 80 feet at the Forks. The flow at the mouth in May 1937, was 112 c.f.s. U.S. Geological Survey records give a maximum discharge of 8,030 c.f.s. on November 23, 1942 and a minimum of 26 c.f.s. late in September, 1943. There

are indications of fluctuations in water level of 5 or 6 feet. Temperature records are 52° to 55° F., May, 1937 and 52° F. October 4, 1945 (Silliman). From 2 to 6 resting pools were observed per mile and there was no pollution, dams, or diversions. The lower 3 miles is in flat tide land and is of no value to salmon. The next 3 1/2 miles contained the best and most extensive spawning areas and four-fifths of the spawning chum and silver salmon observed in 1935 and 1936 were located in this stream section. Although the spawning season was nearly over, 158 chum salmon and 371 silver salmon were counted in December 1935. A fair run of steelhead is reported to ascend to the tributaries in the spring. Resident rainbow fishing is reported as poor. It was estimated that the stream would accommodate at least 3,500 to 4,000 pairs of salmon and that the spawning areas are not fully utilized at the present time.

8A. Beaver Creek: (December 7, 1935; Shuman and Whiteleather.) Tributary to the Alochomin 4 1/2 miles above the mouth, its length is 3 miles, its width 13 feet, the flow was 12 c.f.s. and the temperature 43° F. Only the lower 1 1/2 miles was surveyed. The first mile contains excellent spawning riffles for a few hundred fish, but the value decreases gradually above that point. A count of 94 silver and 27 chum salmon was made and steelhead are reported in the spring. Some debris jams should be removed.

8B. Duck Creek: (December 6, 1935; Shuman and Whiteleather.) Tributary to the Alochomin 7 miles above the mouth, its length is 5 miles, the width 9 feet, the flow 10 c.f.s., the water level fluctuation 1 1/2 feet, and the temperature was 43° F. Only the lower mile was surveyed. There was no pollution, dams, or diversions, but some debris jams were present. The amount of spawning area is limited. Only 2 spawned-out silver salmon were seen, but the stream could support a few more fish than it apparently does at present.

8C. West Fork of Alochomin River: (May 20, 1937; Hanavar and Lobell.) The West Fork joins the East Fork to form the main Alochomin River 15 miles above the mouth. The length is 4 1/2 miles, the width was 21 feet, the average depth was 11 inches, the flow 25 to 30 c.f.s and the temperature 54° F. Water level fluctuations in the canyons may be as much as 10 to 20 feet. The watershed is completely logged off and burned, and the stream has been considerably damaged by the resulting erosion and silting. Only a small part of the stream will be suitable for spawning until the watershed regains its forest cover and the former suitable stream conditions are re-established. The best available spawning areas are located near the mouth and near the forks, and will accommodate several hundred pairs of salmon. Small salmonoid fingerlings, mostly silver salmon, were observed in the lower section. Chum salmon probably also use this stream, but to what extent was not determined. Some steelhead enter in the spring, seven having been observed near the forks. Rainbow trout were present, and the stream was heavily fished by loggers from a camp near the mouth. The stream branches at 3.2 miles above the mouth, each branch having a flow of 10 c.f.s. and good spawning areas for at least 3/4 mile.

FIGURE 3. Logging debris clogging the East Fork of the Alochomin River

FIGURE 4. Lucia Falls, low water barrier on the East Fork of the Lewis River, at low water

8D. East Fork of Alochomin River: (May 20, 1937; Hanavan and Lobell.) Its length is 5 miles, its width is 38 feet, the average depth was 10 inches, and the flow 60 c.f.s. The lower 3.2 miles was surveyed. The estimated gradient was 75 to 100 feet per mile with indications of fluctuations in water level of 6 to 10 feet. A log jam located approximately 2 1/2 miles above the mouth is probably passable with difficulty, and should be removed. There is suitable spawning area for at least 700 pairs of salmon. Logging was still under way and the west bank was being exposed and eroded as a result (Figure 3). These operations were being extended to the remainder of the watershed and will continue to cause silting and erosion for many years. Large numbers of silver salmon and a fair number of steelhead still spawn in the East Fork but chum salmon seldom appear so far up the river. Eleven minor tributaries were counted but none was accessible. The East Fork is formed by the junction of two forks, the right branch and the left branch. An old log jam near the mouth of the right branch is a barrier except during extreme flood stages and the stream above this was not examined.

8D-(1) Left Branch of the East Fork of Alochomin River: (May 20, 1937; Hanavan and Lobell.) Enters 2 1/2 miles above the mouth of the East Fork. The flow was 10 to 20 c.f.s., and the temperature was 48° F. It is an excellent trout stream and has had good spawning areas for steelhead and salmon. Three mature steelhead and many silver salmon fingerlings were observed. Logging extended up this branch for a mile and eventually the entire watershed will have been cut over. The stream bed in the lower mile had been torn up by the logging operations.

9. Birnie Creek:

10. Abe Creek: Birnie Creek and Abe Creek are small streams, approximately 2 miles long. entering the Columbia River near Cathlamet, Washington. Both are blocked by falls a short distance above their mouths and are of no value to salmon.

11. Mill Creek: (October 29, 1936; Hanavan and Whiteleather. May 24, 1946; Zimmer, Fulton, and Brewington.) Enters the Columbia 53 miles above the mouth, just below Oak Point, Washington. This stream is 6 miles long and approximately 3 miles have been surveyed. Above a mile long tidal slough the stream is 15 to 20 feet wide, 4-8 inches in average depth, had a flow of 25 c.f.s., and a temperature of 51° F. The gradient is fairly steep in the first mile, the pools being small, and spawning areas small, scattered, and capable of supporting less than 100 pairs of salmon. A 7 foot falls 1 1/4 miles above the slough is a low water barrier and difficult at other times. A few chum salmon and steelhead are reported to enter the stream, and one steelhead and several redds were seen in May.

11A Little Mill Creek: (October 30, 1936; Whiteleather.) Tributary to Mill Creek about 1 mile above the mouth. Its length is 4 miles and its flow was approximately 3 c.f.s. The first half mile was surveyed, and a small amount of suitable spawning area was found, but this is accessible only at high water because of the falls on Mill Creek. No salmon or steelhead are known to spawn here at present.

12. Abernathy Creek: (October 31 and November 1, 1936; Hanavan and Whiteleather. May 21, 1946; Gangmark and Fulton.) Tributary to the Columbia River about 54 miles above the mouth. Its length is about 13 miles, its width was 8 to 50 feet, the flow at the mouth was 68 c.f.s. in May, 1946; 18 c.f.s. in October, 1945 and 13 c.f.s. in November, 1936. The flow at 9 miles above the mouth in November, 1936 was 9 c.f.s. The temperature was 54° F. in May 1946, and 52° F. in October, 1945. Most of the stream has been surveyed. Although the sparsely settled stream valley is narrow, the gradient of the stream is moderate and there are excellent spawning and rearing areas. Fluctuations in water level of 5-6 feet are indicated. There is no pollution nor any dams or diversions. A 10 foot high falls located 3 1/2 miles above the mouth is a complete barrier to all salmon except during periods of extremely high water during the spring freshets. In 1946 steelheads were observed attempting unsuccessfully to ascend the falls. There are good spawning areas both below and above the falls and it is estimated that the stream could accommodate at least 1,000 pairs of salmon. Since about half of the best spawning area is above the falls, this barrier should be made passable at all times. Other small falls are present 5 1/2 and 12 miles above the mouth. A number of log and brush jams make passage for fish difficult and should be removed. The upper part of the watershed has recently been logged and burned over and is totally barren. Steelhead were observed spawning below the falls in May, and trout and salmon fingerlings were numerous. A fair run of chum salmon spawns in the lower portions of the stream, 92 being counted in November, 1936. A small run of silver salmon is also reported. Rainbow and cutthroat trout, suckers, and lampreys were observed in May. Several small tributaries enter Abernathy Creek besides Cameron Creek (See below) but these appear to have little value to salmon.

12A. Cameron Creek: (October 31 and November 1, 1936; Hanavan and Whiteleather. May 23, 1946; Gangmark and Fulton.) Joins Abernathy Creek about 1/4 mile above the mouth and is its largest tributary. The length is about 6 miles, the width 12-20 feet, and the flow was 18-20 c.f.s. in May. It lies in a narrow valley and the gradient is moderate to steep. There are four low falls in the lower mile, another 4 feet in height 1 1/2 miles above the mouth, and an impassable log jam and fall 2 1/2 miles above the mouth. There are also several log jams in the lower mile that are believed to be impassable. Suitable spawning area is limited and it is estimated that the entire stream could accommodate not more than 100 pairs of spawning salmon. A few chum salmon have been reported near the mouth and a few trout fingerlings were observed.

13. Germany Creek: (November 2, 1936; Hanavan and Whiteleather. May 2, 1946; Fulton and Gangmark.) Enters the Columbia River 56 miles above the mouth, just below the town of Stella, Washington. Its length is 12 miles and its width was 36 feet at the mouth. The flow was 26 c.f.s. in May, 1946, 12 c.f.s. in October, 1945, and 4 c.f.s. in November, 1936. The water temperature was 56° F. in May, 1946, 53° in October, 1945, and 41° in November, 1936. The gradient is moderate below but is considerably greater in the upper reaches. In the 8 miles of the stream that were surveyed there were no dams or diversions. In the upper two miles surveyed there are three low falls, 2 to 4 feet high. A log jam located 1 1/2 miles above the mouth is considered passable, but another about 6 miles above the mouth is a complete barrier and should be removed. This is potentially a good salmon stream with suitable spawning areas for at least 2,000 pairs of salmon. Small runs of chum and silver salmon exist and fish of both species were observed in 1936. In 1946, steelhead were observed spawning in May. Large numbers of suckers and rainbow trout were also seen. It is believed that the productivity of this stream could be materially increased.

14. Falls Creek: (June 12, 1942; Parkhurst.) Enters the Columbia less than a mile above Germany Creek, near Stella, Washington. It is about 2 miles long, but an impassable 40-foot falls located 200 feet above its mouth makes it inaccessible at all times and of no importance to salmon.

15. Coal Creek: (October 29, 1936; Hanavan and Whiteleather.) Tributary to the Columbia River approximately 62 miles above the mouth and about 4 miles below the mouth of the Cowlitz River. Its total length is approximately 14 miles, but the lower 4 miles is a slough. It was surveyed for a distance of 3.2 miles above the slough to an impassable double falls having a lower drop of 12 feet and an upper drop of 6 feet. The stream is 7 to 21 feet wide near the mouth, the average depth was 3 inches, the flow 4.2 c.f.s., the temperature 46° F., and there was an average of 12 resting pools per mile. The gradient is moderate, although there are some fairly steep sections having cascades and falls. A water fluctuation of 10 feet was indicated. There is no dam, diversion or pollution. Three low-water barriers, falls 3 to 4 feet high, are located between 1,300 and 2,400 yards above the slough, and passage over them could easily be improved. There is enough suitable spawning rubble below the impassable falls to accommodate about 200 pairs of salmon. Chum salmon spawn here and a good run of steelhead trout is reported.

15A. Mosquito Creek: A small tributary of Coal Creek entering one mile above the slouth. It was not surveyed but is reported to provide spawning area for a few steelhead trout.

16. Clark Creek: (Inspected June 12, 1942; Parkhurst.) Enters a slough near the mouth of Coal Creek, about 2 miles below Longview, Washington. Its length is 8 miles, its width 24 feet, and its flow was 20 c.f.s. The lower 5 miles is a slough and the stream is of little value for salmon production.

17. Cowlitz River: See Part 2, Sub-area Cowlitz.

18. Owl Creek: Enters the Columbia River 68 miles above the mouth. It is a short stream, and was not surveyed. Chum and silver salmon are reported. A 30 foot falls is reported 1 1/4 miles above the mouth.

19. Fish Pond Creek: A short stream similar to Owl Creek, and entering the Columbia just above it. Not surveyed.

20. Kalama River: (Sept. 20-23, 1936; Hanavan and Whiteleather.) Enters the Columbia 75 miles above the mouth. It is 42 miles long, the lower 20 1/2 miles having been surveyed. It is 250 feet wide at its mouth, and 80 feet wide where the survey was terminated. The flow at Pigeon Springs, about 20 miles above the mouth, was 250 c.f.s. The water temperature was 50° to 56° F. The stream is sluggish in the lower two miles, but the gradient is moderate above and good resting pools average 9 per mile. A shallow bar at the mouth is reported to occasionally prevent the entry of fish during low tide. Eleven miles above the mouth there is a power dam of the Puget Sound Power and Light Company. During periods of low water there is a natural falls 12 feet high between the power intake and its return. A previously inadequate fish ladder built around the falls and dam was replaced with a better ladder in 1944, but a more adequate ladder should be constructed with larger pools and extending at least 75 feet further upstream into a deep pool above the falls and dam. Such a fishway would function automatically at all water levels, whereas passage through the present ladder is quite difficult at low water stages when the power plant is in operation. The power diversion may be a hazard to downstream migrating fingerlings, and probably should be screened. A high falls (Kalama Falls) is located approximately 35 miles above the mouth. There was spawning area for at least 7,000 pairs of salmon in the area surveyed, but it is not fully utilized at present. Additional large spawning areas are reported present in the unsurveyed upper portion of the main river and its tributaries.

The Kalama River has one of the largest runs of fall chinook that now exist in any Columbia River tributary. The State Department of Fisheries annually takes fish from this run for hatchery purposes at racks formerly located about 1 mile above the mouth. In 1936, according to Superintendent Parsons, 13,000 fish were taken from a total run of approximately 20,000. The surplus fish were released above the racks but were often so ripe that they proceeded but a short distance before attempting to spawn. In 1940 the hatchery racks were moved much farther upstream and since that time natural spawning is believed to be much more efficient, although few fish have been observed above the power dam. With an adequate fishway at the dam and falls, more fish would be enabled to reach and utilize the present under-populated upper spawning grounds of this river system. Enlargement of the hatchery facilities is also

contemplated. In 1944 the hatchery is stated to have handled 738 fall chinook, 1,422 silvers and 37 steelhead. It would seem possible to stock the unused upper spawning grounds with spring run chinook after the fishways are rebuilt. A winter run of steelhead and a few chum salmon have been reported.

20A. Little Kalama River: (Sept. 20, 1936; Hanavan and Whiteleather). This stream enters the Kalama River 14 miles above the mouth. It is about 6 miles long, steep, has many difficult cascades, and the rubble is predominantly large. It enters the Kalama over a 5 foot fall, and has little value. No migratory fish are reported.

20B. Rock Creek: (Sept. 23, 1936; Hanavan and Whiteleather.) Also known as Gobar Creek. Enters the Kalama approximately 20 miles above the mouth, near Pigeon Springs. It is 8 miles long, 18 feet wide, and the flow was 7 c.f.s. The lower 2 miles were surveyed to the confluence of Bear Creek. The gradient is moderate to steep, and good resting pools average only 3 per mile, although small cascade pools are plentiful. There are only a few good spawning riffles, the total area being sufficient for about 100 pairs of salmon. A small run of steelhead is reported.

20B-(1) Bear Creek: (September 23, 1936; Hanavan and Whiteleather.) A small, turbulent mountain stream of little importance.

21.)

22.) Two small tributaries, each about 3 miles long and names unknown, enter the Columbia 77 1/2 and 79 miles above the mouth. A few silver and chum salmon were reported to use them.

23.) Rock Creek:

24.) Speelyai Creek:

25.) Burris Creek: None of these was surveyed. They are all small creeks that enter the Columbia between 81 and 83 miles above the mouth.

26. Lewis River: (October 4 to 6, 1936; Hanavan and Whiteleather.) Tributary to the Columbia 85 miles above the mouth, this river is 90 miles long. The portion above the East Fork is occasionally called the North Fork, but is considered here to be the main Lewis River. The lower 20 miles to Ariel Dam was surveyed by boat. This dam, the property of the Northwestern Electric Company, was built in 1931 and is 240 feet high at the spillway. Extensive areas above the dam were not surveyed. The stream is approximately 250 feet wide at its mouth, and 165 feet wide at the dam. The flow was 2,900 c.f.s. at the dam. U. S. Geological Survey records from a station located 1/2 mile below Ariel Dam

give the drainage area as 731 square miles, not including the East Fork or lower Cedar Creek. The maximum discharge is given as 57,600 c.f.s. on November 23, 1942, the minimum as 90 c.f.s. on September 12, 1936, and the mean discharge as 4,429 c.f.s. Below the dam the mean depth of the river is over two feet and the gradient is less than 4 feet per mile. In general the stream below the dam is sluggish and there are few good resting pools. There is no spawning area in the lower 7 miles, where the bottom is mainly composed of mud and sand; but there is suitable spawning area in the 13 miles immediately below the dam for at least 7,000 pairs of salmon. This was not completely utilized, although numerous spawning silver salmon were observed. The water temperature was 59 to 61° F.

The Lewis River is one of the most important producers of silver salmon in the entire Columbia Basin. There are fairly good runs of fall chinook and steelhead and runs of spring chinook, chum salmon, and cutthroat trout.

At the present time the Washington State Department of Fisheries operates a fish trap at the dam. A portion of the salmon secured at the trap are taken for hatchery propagation. Eggs from these fish are held until eyed at the Cougar Creek hatchery, 18 miles above the dam. Part of the resulting fry are reared at Cougar Creek, and part are taken to another State hatchery 3 miles below the dam. In 1944 the Lewis River hatchery is reported to have spawned 259 spring chinook, 206 fall chinook, 7,919 silvers, and 347 steelhead. The rest of the salmon and steelhead trapped at the dam are lifted over the dam and liberated in the waters of Lake Merwin (Ariel Reservoir) so that they can proceed to natural spawning areas above the dam. Downstream migrating fingerlings pass over the sloping spillway of the dam without material loss, according to the State authorities.

26A. East Fork of Lewis River: (October 6-14, 1936, and Aug. 7, 1937; Hanavan, Whiteleather, and Lobell.)
This tributary (also known as the South Fork) enters 5 miles above the mouth of Lewis River. It is 42 miles long, and the lower 36 miles to Green Fork have been surveyed. It is about 90 feet wide, and the temperature was 56° to 59° F. The lower 6 miles is in a valley one or two miles wide and used for pasturage. The remainder of its course is in a narrow valley. A large part of the watershed was burned over in the fire of 1902. Portions have been further damaged by more recent fires, and are now covered with brush and snags. Records of the Geological Survey give the mean flow in April 1937 as 1800 c.f.s., with a maximum of 15,600 c.f.s. on December 22, 1933, and a minimum of 29 c.f.s. on November 3, 1935. These figures were taken at a station 18 1/2 miles above the mouth, and include the drainage from the upper 125 square miles of the basin.

There are many partial obstructions in the middle and upper portions of the stream that should be removed or made more easily passable. Twenty one miles above the mouth the 14 foot high Lucia Falls is a total barrier to salmon, although steelhead ascend during high water (Figure 4). Two falls, each about 4 feet high, occur in the 700 yards just above Lucia Falls. Three miles above Lucia Falls there is an 8 foot falls, and a half mile above this there is a 9 foot falls that is a low-water barrier. Between 26 and 27 miles above the mouth there are four falls 3 to 9 feet in height. Horseshoe Falls, 28 1/2 miles above the mouth, is 18 feet high, but some steelhead are said to pass this falls during high-water periods. There are two large log jams about 2 1/2 miles above Horseshoe Falls. Sunset Falls, 31 1/2 miles above the mouth, is 16 feet high and is considered to be a total barrier. The occasional "steelheads" reported seen above it are probably large resident rainbows.

In the lower 6 miles the bottom is largely mud and sand. An employee of the Washington State Fisheries Department reported that in 1944 a bar, formed by debris from a gravel crusher, temporarily blocked fish passage for a month, but that the situation has been remedied. Spawning area is available for about 4,000 pairs of salmon below Lucia Falls and for at least 1,600 pairs between Lucia and Sunset Falls. There is a large run of silver salmon and a smaller run of fall chinook salmon in this stream. The survey party counted 1,166 silvers and 81 chinook below Lucia Falls in October, 1936. A good spring run of steelhead is reported, and 40 spent fish were observed in a pool below Horseshoe Falls on August 7, 1937. A fair run of sea-run cutthroat is also reported.

26A-(1) Lockwood Creek:
(2) Bee Tree Creek:
(3) Lower Rock (?) Creek: These streams enter the East Fork of Lewis River a short distance above La Center, Washington. They are respectively 5, ?, and 5 miles in length, but were not surveyed.

26A-(4) Big Tree Creek: (October 13, 1936; Whiteleather.) This stream enters the East Fork 23 miles above the mouth and is presently accessible only to the few steelhead that can ascend Lucia Falls on the East Fork. It is 7 miles long, had a flow of 3 c.f.s. and is reported to have been a good trout stream.

26A-(5) Rock Creek: (October 15, 1936; Hanavan and Whiteleather.) This stream enters the East Fork approximately 25 miles above the mouth. The lower 3.8 miles of its total length of 14 miles were surveyed. Its width is 26 feet, the flow was 16 c.f.s., and the temperature 52° to 54° F. The gradient is moderate and there were sufficient good resting pools. One mile above the mouth there is a 5 foot falls that may be a low-water barrier to salmon. Suitable spawning area for at least 400 pairs of salmon was present in the section surveyed, and there is possibly more above. Both a spring and fall run of steelhead were reported, the latter being small. Sea-run cutthroat were also reported in considerable numbers.

26A-(5)a Cedar Creek: (October 15, 1936; Hanavan.) Enters 2 1/2 miles above the mouth of Rock Creek. Its length is 6 miles, its width was 26 feet, and the flow 6 c.f.s. The lower 2.3 miles were surveyed. There is much large rubble, but favorable spawning area is available for at least 200 pairs of salmon. A fair run of steelhead is reported.

26A-(5)b Coyote Springs Creek:
Grouse Creek: (October 15, 1936; Hanavan.) Both are too small, steep, and swift to be of appreciable value for salmon.

26A-(6) King Creek: (October 13, 1936; Whiteleather.) Enters the East Fork 27.3 miles above the mouth and just below horsefall Falls. It is 4 miles long, but apparently has little value for salmon production.

26A-(7) Copper Creek: (October 15, 1936; Whiteleather.) This stream enters the East Fork 30 1/2 miles above the mouth and less than a mile below Sunset Falls. It is 6 1/2 miles long, but is blocked 60 yards above the mouth by an impassable 18 foot falls. Three tributaries, Star, Summit, and Miners Creeks, all enter above the falls.

26A-(8) Slide Creek:

26A-(9) McKinley Creek:

26A- (10) Little Creek:

26A-(11) Green Fork: These tributaries are all steep and of no significant value for salmon.

26B. Cedar Creek: (August 6 to 8, 1937, Hanavan, Kolloen, Baltzo and Lobell.) This stream enters the main Lewis River 16 1/2 miles above the Columbia River, and 3 1/2 miles below Ariel Dam. Its length is 20 miles, the width 20 to 70 feet, the flow was 35 c.f.s. and the temperature 58° to 65° F. The lower 12 miles below the town of Yacolt was surveyed. The gradient is moderate, 20 to 40 feet per mile, and resting pools average 23 per mile. Pollution from the town of Amboy was noted but was not sufficient to affect fish. The lower 3 miles is in a ravine, but most of the stream flows through a well farmed valley bottom.

A marshy section obstructed by beaver dams and brush jams occurs about 9 miles above the mouth. Some 2 1/4 miles above the mouth there was formerly a mill dam 22 feet high built in 1876 on top of a falls. A fish ladder built in 1905 opened 100 feet below the dam and was very ineffective. The diversion at the dam was inadequately protected

with a 1" mesh screen when inspected by the survey party. This dam had blocked fish for generations until it was removed by the State Department of Fisheries in 1946. At present a highway culvert between Yacolt and Amboy is difficult for fish to pass because of the fast flow of water through it. The State Fish and Game Departments are planning to have baffles installed in the culvert to provide easier and more certain fish passage. A bypass was constructed around a large log jam located above the dam site by the State Fish and Game departments in 1945. There is spawning area below the falls at the dam site for at least 600 pairs of salmon, and spawning area above the damsite for an additional 2,200 pairs. In the past the state has installed racks about 500 yards above the mouth to obtain salmon for the Lewis River Hatchery, but in the last several years it is reported that the racks have been opened to allow the fish to spawn naturally. A good run of silver salmon is reported, although it is said that in some years many were unable to get past the mill dam. Sea-run cutthroats ascend the stream, and a few fall chinooks have been reported.

26B-(1) John Creek:

26B-(2) Brush Creek: These small creeks, and several others with names unknown, enter the lower part of Cedar Creek but are of little value.

26B-(3) Chelatche Creek: (August 8, 1937; Lobell.) Enters Cedar Creek 9 miles above the mouth. The survey was discontinued at a forks 740 yards above the mouth. The total length, including the south fork is 6 miles, the width was 15 feet and the flow 10 c.f.s. Most of the valley through which it flows is under cultivation. Domestic sewage from the town of Amboy and dairy pollution discolor the water and probably cause unfavorable conditions for fish. No fish were seen, and although there is some suitable spawning area, the stream is of little value.

27. Salmon Creek: (October 27, 1936; Hanavan, Whiteleather, and Baltzo.) This stream enters approximately 94 miles above the mouth of the Columbia River and 10 miles below Vancouver, Washington. It is 22 miles long, of which 14 1/2 miles were surveyed. It is 45 feet wide and gradient is low, 15 to 16 feet per mile. Temperatures ranged from 46° to 49° F. and resting pools averaged 12 per mile. There were 3 beaver dams and 3 log jams observed that may be low-water barriers, the first of these being about 8 miles above the mouth. The lower 2 1/2 miles of stream meanders through flat terrain, often in several changeable channels, and has no value from the viewpoint of fish production. There is suitable spawning area for 2400 pairs of salmon in the remainder of the stream, most of it above the lower 4 1/2 miles. Silt washed in from farmed lands and more especially from gravel crushers has made other areas unsuitable. Silver salmon, fall chinooks, and sea-run cutthroats enter this stream to spawn, and a few chum salmon and steelheads are

also reported. The survey party counted 16 silver salmon and 19 chinook salmon, but the presence of decomposed carcasses of other spawned-out chinook indicated that much of the spawning of this species had probably occurred in early September. The 1936 run was reported to be unusually small, probably due to exceptionally low water, but during the first week in October, 1947, a large number of salmon, believed to be silvers or fall chinook, were reported in this creek.

27A. Whipple Creek: Tributary to lower Salmon Creek. It was not surveyed.

27B. Mill Creek: (October 27, 1936; Baltzo.) Enters Salmon Creek 6 miles above the mouth. Its length is 4 miles, and its width was 3-9 feet. Only the lower 900 yards were surveyed, and the stream was so shallow that it appeared impossible for salmon to enter. There was an impassable brush jam 340 yards above the mouth. The lower portion of the stream is sluggish and muddy, but in the upper sections there is a small amount of spawning area that would be accessible with higher water conditions. Residents reported "salmon" entering late in the fall or in the winter, but these may be steelhead.

28. Washougal River: (July 21 to 27, 1935; Suomela and Shuman.) Enters the Columbia River 121 miles above the mouth, near Camas, Washington. Its total length of 36 miles was completely surveyed. It was 50 feet wide at the mouth, had a flow of 62 c.f.s., and the temperature was 61° to 74 1/2° F. in the lower portion and 57° to 62° F. in the upper 16 miles. The gradient is slight to moderate, with resting pools averaging 4 per mile. Much of the watershed was burned over in the fire of 1902, and parts were burned again in 1927 and 1929. The upper portion of the watershed has been closed to the public since that date. Severe floods and erosion of the deforested slopes followed these fires and have greatly reduced the value of this stream. Present spawning areas are generally confined to narrow strips along the lower margins of pools, the riffles now being composed mainly of rubble too large for spawning.

There were formerly 3 dams owned by the Cotterell Power Company and located on the lower Washougal River that blocked fish runs. One of these washed out a score of years ago. When inspected by the survey parties, the other two dams were considered to be low water barriers in spite of the presence of poor fish ladders. One of the two was removed in 1944 after court action by the Washington State Department of Game, and the remaining dam was removed in April 1947, as a result of joint action by the State Fisheries and Game Departments.

Salmon Falls, 17 1/2 miles above the mouth, is 8 feet high and very difficult for salmon to pass at low water. Improvements should be made to assure fish passage over it at all water stages.

Approximately 30 miles above the river's mouth, near the end of the Washougal Ranger Station road, there is a 25 foot falls that is a total barrier to salmon and may block steelhead in some seasons. In the next 6 miles above the falls there are 8 falls and cascades, each 7 to 15 feet in height, that are at least low water barriers. There are also many stretches of bare bedrock, particularly above the falls. There is spawning area for approximately 5,000 pairs of salmon below Salmon Falls, sufficient for at least 1,000 pairs between Salmon Falls and the Ranger Station Falls, and for 600 more pairs above this barrier. It would therefore appear feasible to build a fishway at Salmon Falls, but the upper falls would not warrant attention at the present time. The entire stream should gradually improve as the watershed is reforested and floods become less severe.

The largest run of fish now entering this stream is of steelhead. The survey party counted 539, the majority of which were unspawned fish lying in deep holes. Some 200 were seen below Salmon Falls, and the others above. Apparently none of these fish would spawn until the following spring. Older residents stated that an early spring run spawns immediately upon entering the river, but other fish appear from time to time and "hole up" and do not spawn until the following spring. No spring runs of chinook were reported, but a fall run of "tules" (nearly ripe chinook salmon) is said to enter the river in September. In November 1934, the first good silver salmon run in more than 22 years was reported, and fair runs have subsequently been reported. Salmonoid fingerlings were observed to be numerous. Cutthroat and a few brook trout were also reported. Shad spawn at the mouth of the river, mainly in Camas slough, and suckers, dace and warmer water fish were noted in the lower reaches.

The chief detriment to this stream is the pollution at its mouth by the sulphite effluent of the Camas paper mills which, according to the State Pollution Control Commission, is equivalent to pollution from a city of 1,155,000 population. It is most dangerous to summer and fall run fish in particular, as the discharge is made into Camas Slough inside of Lady Island in the Columbia, and during low water periods the approach of fish to the Washougal River might be blocked by pollution in this channel. This pollution can and should be eliminated, as indicated by the Commission's recommendation to carry the effluent across Camas Slough and Lady Island to the main Columbia River channel (see Wash. State Pollution Control Comm. Progress Report No. 12, August 1, 1947.)

28A. Lacamas Creek: (August 6, 1937; Lobell.) Also spelled La Camas Creek. Enters less than a mile above the mouth of the Washougal River. It is 16 miles long and was surveyed for 3/4 mile to an impassable 70 foot falls. About 1/2 mile above the falls is a 30 foot dam of the Camas Paper Mill. Black bass are established in the reservoir above this dam and the temperature is believed to be fairly high. Because there is little spawning area below the falls and much of this section is covered during high water periods by backwaters from the Columbia and Washougal Rivers, the stream has little present value.

28B. Little Washougal River: (July 28-29, 1935; Suomela and Shuman.) It enters the Washougal 4 1/2 miles above the mouth, and is 13 miles long. The section of this stream that is above the East Fork is sometimes designated as Boulder Creek. Its width is 20 feet, the flow was 9-20 c.f.s., and the temperature 57 1/2° to 61° F. The gradient is moderate and resting pools average 6 per mile. An abandoned mill dam 11 1/4 miles above the mouth is a low-water barrier to all fish and a high-water barrier to all but a few steelhead trout. A quarter of a mile above this dam there is a 4 foot dam of the Camas Water Supply Company. Nearly all the flow of the stream is diverted here through an unscreened flume. The stream above is only 6 to 8 feet wide and has a low-water flow of 8 to 15 c.f.s. When sufficient water is available below these dams there is suitable spawning area for about 1,200 pairs of salmon. Steelhead, and silver salmon are reported, and one adult steelhead was observed. Trout fingerlings were numerous.

28B-(1) East Fork:

28B-(1)a Jones Creek: These streams were not surveyed but are reported to provide little additional spawning area. There is a water supply dam near the headwaters of Jones Creek.

28C. Canyon Creek: (August 6, 1937; Hanavan and Lobell.) Also known as Cougar Creek. Enters the Washougal River 12 miles above the mouth, and is 4 miles long. It is blocked at its mouth by 2 impassable falls, each 15 feet high, and therefore has no value for salmon production.

28D. West Fork of the Washougal River: (July 29-30, 1935; Suomela and Shuman.) This stream enters the Washougal 13 miles above the mouth. Its length is 23 miles, its width 25 feet, the flow was 20 c.f.s., and the temperature 61° to 63° F. It was surveyed for 5 1/2 miles to an impassable 18 foot falls. The gradient in the section surveyed averaged 84 feet per mile, but above the falls it averages 204 feet per mile. Resting pools averaged 10 per mile. The stream flows through a deep canyon between well forested hills and mountains. About 60 percent of the bottom is of large rubble, but there is suitable spawning area for about 900 pairs of salmon. Steelhead are the only fish reported in this stream; 4 adults and numerous small fingerlings were observed.

28D-(1) Texas Creek: (August 6, 1937; Lobell.) Enters the West Fork 3 miles above the mouth. Its length is 5 miles, its width was 11 feet, the flow 7 c.f.s. and the temperature 51° F. The survey was terminated at a 9 foot falls located 1,000 yards above the mouth that is impassable to salmon and perhaps to steelhead. Resting pools were few and small. Sixty percent of the bottom below the falls was bedrock and spawning areas were scattered, with the best being located in the lower 1/4 mile. Trout fingerlings were scarce.

28E. McCloskey Creek: (August 6, 1937; Hanavan.) This stream is 5 miles long and enters the Washougal 16 1/2 miles above the mouth. An employee of the Washington State Fisheries Department stated that steelhead had been observed below a falls 8-10 feet high, located near the mouth. Good spawning areas are reported above the falls, but they are inaccessible until the falls are made passable.

28F. Dougan Creek: (August 6, 1937; Hanavan and Lobell.) Enters the Washougal 21 miles above the mouth. Its length is 3 1/2 miles and its flow was 2 c.f.s. Entrance into the stream is prevented by a series of impassable falls just above the mouth, and it is therefore of no value to salmon.

28G. Stebbins Creek: (July 27, 1936; Suomela and Shuman.) Enters the Washougal 24 miles above the mouth. It is 6 miles long and the lower 1.7 miles were surveyed to an impassable falls. Its width is 19 feet, and flow was 6 c.f.s., and the temperature 58° to 62° F. The stream flows through a box canyon in a hilly section. There are a few good spawning areas and pools in the lower 3/4 mile but the rest of the stream is of little value due to its steep gradient. A few steelhead are reported below the falls.

28H. Timber Creek:

28I. Silver Creek:

28J. Prospector Creek:

28K. Meander Creek:

28L. Grouse Creek:

28M. Lookout Creek:

28N. Bear Creek: These are all turbulent mountain streams that have never provided spawning areas for salmon and for only a few, if any, steelhead trout. They are of little value for fish production.

29. Gibbons Creek:

30. Walton Creek:

31. St.Cloud Creek: These are all small tributaries of the Columbia River entering between 2 and 7 miles above Washougal, Washington. They were not surveyed.

32. Duncan Creek: (April 20, 1937; Lobell.) Enters the Columbia about 1 mile below Skamania, Washington, and is 5 miles long. The lower section was inspected while it was in flood and flowing 30 c.f.s. The stream is reported to be intermittent in the summer so that small steelhead are often trapped in isolated pools. It is in a brush-bordered ravine and has little spawning area.

33. Woodward Creek: (April 20, 1937; Lobell.) This creek enters the Columbia about 1 mile above Skamania, Washington. About 4 miles above the mouth there is a network of small tributaries in a swampy area. The creek had a freshet flow of 20 c.f.s., but the lower portion has been channeled for flood control, has much large rubble and is virtually dry during the summer. It is reported that steelhead occasionally become trapped in small pools as the stream dries up, and that a few chum salmon spawned near the mouth in 1944.

34. Hardy Creek: (April 20, 1937; Lobell.) Enters the Columbia River 3 miles above Skamania, Washington and is similar to Woodward Creek. Rodney Falls, 3/4 mile above the mouth, may be a total barrier. The stream is of little importance.

35. Hamilton Creek: (June 29, 1937; Hanavan.) Enters the Columbia River 4 miles above Skamania. The lower 3.7 miles was surveyed to an impassable falls. Its length is 7 1/2 miles and its width 12-36 feet. The flow during a freshet was 40 c.f.s., but the stream has very little water in late summer and early autumn. The gradient is steep, 350 feet per mile, and there is little suitable spawning rubble. Flood control work along the channel hastens the run-off. A small run of steelhead is reported.

35A. Greenleaf Creek: This small creek joins Hamilton Creek a short distance above the mouth. It is 5 miles long and has a small pond-like area just above the junction with Hamilton Creek. It was not surveyed.

36. Blue Lake Creek: Enters the Columbia River about 4 miles above Bonneville Dam. It is 2 miles long and rises in two small ponds. It was not surveyed.

37. Rock Creek: (November 3, 1936; Baltzo.) Enters the Columbia 151 miles above the mouth. Its length is 14 miles, the

width 18 feet, and the flow was 7 c.f.s. The lower 7 miles were surveyed. The gradient is fairly steep except for the lower 1/2 mile, and the stream is subject to sudden freshets and a fast run-off that has left little rubble small enough for spawning use. There were two log jams and two beaver dams that were difficult for the passage of fish. About one mile above the mouth there is a series of 7 falls having a combined drop of over 65 feet, and about a quarter of a mile farther upstream there is a 25 foot falls. There is some spawning area below the falls and a few chinook and steelhead are reported.

38. Nelson Creek: (April 21, 1937; Lobell.) Enters the Columbia River about one mile above Rock Creek. It is about 2 miles long, had a flow of 2 c.f.s., and flows through a brushy ravine. The bottom is poor and the stream has little value. A falls is reported within one mile of the mouth.

39. Carson Creek: Enters the Columbia River 154 miles above the mouth. It is only 3/4 mile long and resembles Nelson Creek. It has no value for salmon.

40. Wind River: (November 20 and 21, 1935; Shuman and Whiteleather, from mouth to Trapper Creek, 18 miles up. Next 4 miles September 25, 1936 by Hanavan and Whiteleather. Lower 2 miles to the falls re-surveyed September 15 and 21, 1940, by Parkhurst and Bryant.) Enters the Columbia 155 miles above the mouth, is 32 miles long, and the lower 22 miles have been surveyed. It is 150 feet wide at the mouth and is generally 50 to 70 feet wide in the lower 10 miles. The flow on September 14, 1940 was 164 c.f.s. The mean flow during the high-water period from December to May is given by Geological Survey records as 1200 to 3000 c.f.s. with an occasional peak flood of 7000 or 8000 c.f.s. The mean flow during the period of low water is usually 160 to 800 c.f.s. Water temperatures were 40° to 42° F. on November 24, 1935, and 54.5° on September 21, 1940. The gradient above the lower mile is moderate to fairly steep and resting pools average 20 per mile. The river is in a rocky canyon for several miles above the mouth, and is elsewhere bordered by steep hills or mountains.

Backwater from the forebay of the Bonneville dam floods most of the lower 1 1/2 miles of the stream. This ponding has covered most of the formerly available spawning area near the mouth and the State hatchery at the mouth was closed after its former holding and racking site had been flooded by the backwaters. Three and seven tenths miles above the mouth there is a series of 3 falls collectively known as Wind River or Shepard Falls (See Figure 5). The first is 3 to 5 feet high and easily jumped. The second is a cascade 12 to 15 feet high and impassible to salmon. The third falls is nearly as high and is also impassable. An attempt to blast a channel around the falls was made in 1936, but it has never been completed and is dry during low-water periods (visible to the right of the main flow in Figure 5). Steelhead struggle over the falls during spring high water. Several other falls and cascades occur within the next mile above, and for about 7 miles the stream is

steep and rough with little suitable spawning area. The next three miles, however, contains some excellent spawning rubble. Approximately 14 miles above the mouth, the Carson Lumber Company formerly maintained an 8 foot high mill dam with a 14 foot apron which completely blocked even the steelhead runs from the upper spawning areas and from the Carson hatchery of the Fish and Wildlife Service. In February, 1947, the State Fish and Game departments jointly compensated the lumber company for the dam and removed it from the stream.

The backwater of Bonneville Dam has flooded out spawning area adequate for over 1,000 salmon. At present the available spawning area below the falls can accommodate at most only a few hundred fish. Between the falls and the formerly impassable dam there is suitable spawning area for at least 2500 pairs of salmon, but this is presently available only to spring steelhead. Above the dam site (and entirely inaccessible until the dam was removed) there is spawning area for at least 1,500 pairs of salmon. If the suitable areas of the main stream alone could be made available, several thousand spawning fish could be accommodated, and the Fish and Wildlife Service hatchery at Tyee Springs, approximately 15 miles above the mouth, could better aid in the improvement of both salmon and steelhead runs. The hatchery crew now racks the stream just above the Bonneville backwater in order to secure a spawning stock of fall chinook. About 1,000 fish were taken here in 1946. In September, 1940, about 200 fall chinooks were jumping at the falls, and others were seen ascending the stream below. A fair run of steelhead is reported to have ascended as far as the dam during the spring high water period, and should now be able to continue farther upstream. There are apparently no runs of spring chinook or silver salmon utilizing the stream at present, although spring chinook fingerlings have been released by the hatchery in recent years.

40A. Little Wind River: (June 30, 1937; Hanavan.) Enters Wind River 1.9 mile above the mouth. Its length is 6 miles, the width was 18 feet, the flow 15 c.f.s., and the temperature 56° F. The lower 1.8 mile was surveyed to a point where the stream appeared to be too steep and rough to be of value. The gradient is steep, 125 feet per mile, and small resting pools average 23 per mile. The most suitable spawning areas are above several log jams that have been filled in from above with gravel. One and one half mile above the mouth is an 8 foot falls that is a barrier to all salmon and is difficult for steelhead. Suitable spawning area exists for at least 250 pairs of fish, but this is mainly in the lower mile. Numerous steelhead redds and many fingerlings were seen below the falls, indicating that the spawning area is fairly well utilized by that species. No salmon runs are reported.

FIGURE 5. Shepard Falls on Wind River in May

40B. Brush Creek: (June 30, 1937; Hanavan.) Enters Wind River 2.7 miles above the mouth. It is about 2 miles long and drains a burned-over mountain side. It is subject to a quick run-off, is nearly dry in the summer, and is of little value for salmon.

40C. Bear Creek: (November 25, 1935; Shuman and Whiteleather.) Enters Wind River 4.3 miles above the mouth. It is 7 miles long and 23 feet wide. The lower 1/4 mile was surveyed to an 18 foot falls. There is suitable spawning area below the falls for only a few pairs of fish.

40D. Panther Creek: (November 25, 1935, September 30, 1936, and July 2, 1937; Whiteleather, Shuman, and Hanavan.) Enters Wind River 4.3 miles above the mouth. It is 13 miles long and was surveyed to a forks 9 1/2 miles above the mouth. Approximately 8 miles above the mouth the flow was 52 c.f.s. The water temperature was 41° to 45° F. on November 25, 1935, and 60° on July 2, 1937. The lower 3 1/2 miles and the upper 2 1/2 miles lie in steep canyons. Between these sections the stream flows through a narrow valley and has several series of excellent pools and riffles that could accommodate over 1500 pairs of spawning salmon if the falls on lower Wind River were made passable. Four falls between 5 and 10 feet in height located in the upper 3/4 mileof the section surveyed are low-water barriers, and there are also several log jams. The main creek is reputed to be an excellent steelhead stream. Only 4 steelheads were observed during the survey, but visibility was poor and others were probably present. The North Fork is too precipitous to be of value, and the South Fork is inaccessible because of a 15 foot falls near its mouth. The South Fork flows over a porous lava bed below its origin in Sheep Lakes. This section is dry in summer, and the stream reappears as springs about 5 miles below.

40D-(1) Cedar Creek: (November 25, 1935; Shuman and Whiteleather.) Also known as Clear Creek. Enters Panther Creek 2 miles above the mouth. It is 6 miles long and the survey was terminated 600 yards above the mouth where 3 impassable log jams were encountered. The stream was 9 feet wide, and the temperature was 42° F. There are numerous small pools and riffles. According to several persons interviewed, this was once an excellent steelhead and trout stream, and a representative of the State Game Department reported that there was spawning area adequate for several hundred fish. However, in 1933 and 1934, in spite of numerous protests, CCC workers felled much timber along the banks and dumped logs, stumps, and brush directly into the stream, causing jams. The stream could easily be reclaimed at small cost and should be restocked when the barriers have been removed. The remainder of the stream should then be surveyed.

40E. Trout Creek: (September 26, 1936; Whiteleather.) This tributary enters Wind River 10 miles above the mouth. The lower 6.8 miles have been surveyed a total length of 10 miles. Its width is about 14 feet, the flow, during a low-water period, was 5 c.f.s.,

and the water temperature was 44° to 47° F. The gradient is fairly steep and there are many cascades, particularly in the lower 5 miles where suitable spawning areas occur in only small patches. Better spawning areas were found higher up.

The watershed is rugged, and most of it has been set aside for an experimental timber growth plot by the Forest Service. Approximately 2 miles above the mouth is a 20 foot concrete dam that, at the time of the survey, was diverting nearly all of the water to run an electric generator for the Forest Service. The State Fisheries Department has constructed a fish ladder over the dam. It is reported that the Forest Service abandoned this diversion dam in 1944. About 0.7 mile above this dam is a second one, 4 feet high, used by the Forest Service to provide a camp water supply. The diversion is through a 12 inch pipe and the intake is screened. During low water periods the stream is nearly dry below the dam. A formerly inadequate fish ladder was replaced with a satisfactory one in 1941 by the Forest Service. Several small jams and cascades in the stream should be improved. It is reported that a few steelhead spawn in the stream, and fingerling trout were numerous. A small creek, Martha Creek, enters near the mouth of Trout Creek, but it is steep and has little value.

40F. Hollis Creek: Tributary to Wind River 14 1/2 miles above the mouth, and just above the Carson Lumber Company dam site. It is a short stream, steep, and of little value.

40 G. Cold Creek: (July 26, 1935; Suomela and Shuman.) Enters Wind River 14.7 miles above the mouth. It originates in a large spring one mile above and had a flow of 21 c.f.s., and a temperature of 43°-45° F. It was not surveyed in detail.

40H. Tyee Springs Creek: This short spring fed stream, sometimes known as Siouxon Springs Creek, enters Wind River about 15 miles above the mouth, and has been described in detail by Davidson and Wilding (1943). It is now the site of the Carson hatchery of the U. S. Fish and Wildlife Service, which has greatly enhanced the original natural value of the stream as a fish producer. With the mill dam now removed from Wind River, there remains only the improvement of the lower Wind River falls to make possible the direct ascent of both salmon and steelhead to the hatchery.

40I. Trapper Creek: (Lower 3/4 mile, November 24, 1935; Shuman and Whiteleather; next 1 1/4 mile, July 2 and August 7, 1937; Whiteleather and Hanavan.) Enters Wind River about 18 miles above the mouth, is 6 miles long and was surveyed for 2.1 miles. Its approximate width is 30 feet, its flow on August 7 was 20 c.f.s., and the temperature on July 2 was 49° F. The first mile above Wind River is a narrow artificial channel through Government Springs Camp.

Immediately above the camp, debris jams make passage difficult. Above this the stream meanders through several channels with adequate spawning area for at least 300 pairs of salmon. Resting pools are small, but average about 25 per mile. The upper portion of the stream is too steep to be of value. A few steelhead are believed to enter the stream. Lost Creek, entering at 2 1/4 miles up is the largest tributary and had a flow of 7 to 8 c.f.s. on July 2, 1937. After the spring run-off it is so small that fish could not ascend for any distance.

40J. Dry Creek:

40K. Nine-mile Creek: Enter Wind River 18.4 and 20 miles above the mouth, respectively. They are reported to be nearly dry in late summer and of little or no importance to fish maintenance.

40L. Falls Creek: (September 25, 1936; Whiteleather.) Enters Wind River 21 miles above the mouth. Its length is 9 miles, and its flow was 2 c.f.s. The watershed has been burned over, and consequently freshets have scoured the streams so that the bottom is now nearly all bedrock and large boulders. There are impassable falls 1 mile above the mouth, and the stream as a whole is of negligible value.

40M. Paradise Creek:

40N. Old Man Creek: These are short tributaries to Wind River, 24 and 26 miles above the mouth. They are small and of no value for salmon.

41. Collins Creek:

42. Dog Creek: (April 21, 1937; Lobell.) Small creeks entering the Columbia River 7 and 5 miles respectively below the Little White Salmon River. Both are blocked by impassable falls within 1 mile, and have no value for salmon production.

43. Little White Salmon River: (October 1, 1936; Hanavan and Whiteleather.) Enters the Columbia River 162 miles above the mouth, and is approximately 18 miles long, but there is an impassable falls 1 3/4 miles above its confluence with the Columbia. The backwater from Bonneville Dam now extends to within 1/2 mile of these falls, and covers all of the area that was originally suitable for salmon spawning. A railroad embankment about 1/2 mile below the original mouth of the river cuts off a shallow embayment from the Columbia River and forms a pond known as Drano Lake. The river now flows through this lake and enters the Columbia River through a narrow, deep channel. The gradient in the first few miles

above the falls is steep, and a succession of rapids, cascades and small falls would be hazardous to fish passage; but above this section are several miles of excellent spawning and rearing area. If this could be made accessible to salmon by the construction of a fish ladder around the lowest falls and removing the lesser obstruction above, the natural productivity of the river would be increased many fold. For many years a U. S. Government salmon hatchery has been operated near the mouth of the stream. The small run of chinook salmon that originally spawned in the limited area below the falls was soon built into a run which consists of several thousand fish in addition to those taken by the ocean troll and lower Columbia commercial and sports fisheries. The chinook egg take at the station was 5,870,000 in 1946, 8,670,000 in 1947, and 14,112,000 in 1948. The hatchery facilities are being enlarged to accommodate even larger numbers of fish in the future.

Alaska sockeye were introduced about 1916, and a run was maintained for several generations. In recent years blueback salmon have been liberated from stocks transferred from other points on the Columbia. Adults from these releases have returned to the hatchery and a large number of marked fish has been recovered from the commercial fishery. Eggs taken from the returning adults totaled 46,300 in 1946, 131,300 in 1947, and 516,550 in 1948. Some steelhead, and a few silvers also enter the White Salmon River.

44. Spring Creek: This small creek flows into the Columbia River about 5 miles above the Little White Salmon River. It has its origin in several large springs located on the steep bank of the river. The stream was originally only about 100 yards in length and was inaccessible to salmon because the water flowed thinly over a rock ledge as it entered the Columbia River. About 1902 a small hatchery was established by the U. S. Government on the Creek and used to incubate eggs taken from fish trapped at Rowland Lake bar in the Columbia and later from the fall chinook salmon runs into the White Salmon River. In due time a run of adult chinook salmon appeared at the mouth of the tiny stream and provision was made for them to enter the hatchery ponds by means of a small fish ladder. The run rapidly increased and in 1946 12,365,000 eggs were taken from fish returning to this station. In 1947, the station took 12,376,000 eggs, and gave an additional 5,800,000 to the Fish Commission of Oregon. In 1948, 17,247,000 eggs were taken. The young salmon are now planted in Spring Creek and in the White Salmon River, the original source of the eggs; a surplus of several million is used for planting in other depleted streams.

Several hundred marked chinook from this station have been recovered annually from the Columbia River Commercial and sports fishery during the past several years.

45. White Salmon River: Enters the Columbia River 168 miles above the mouth, and is 40 miles long. An impassable power dam is located 2 1/2 miles above its mouth, and because of this the river system was not surveyed. If consideration is ever given to making possible the passage of fish over the power dam, the entire system should be surveyed. It was mentioned above (See Spring Creek, No. 44) that the Fish and Wildlife Service's hatchery on Spring Creek now takes eggs annually from the fall run of chinook that enters the White Salmon River. In both 1945 and 1946, 10,700,000 eggs were taken; in 1947, 14,008,000, and in 1948, 7,827,000 were taken; all these in addition to the eggs taken by the Underwood hatchery at Spring Creek.

46. Catherine Creek:

47. Major Creek: These streams enter the Columbia River 8 and 9 miles, respectively, above the White Salmon River. Both are of no present value for salmon production because of impassable falls just above their confluence with the Columbia River.

48. Klickitat River: (Lower 30 miles, November 7 and 8, 1938; Hanavan, Parkhurst and Morton. The next 35 miles inspected September 5, 1942; Parkhurst.) Enters the Columbia 180 miles above the mouth, and is 95 miles long and 60 to 120 feet wide in the lower reaches. A high-water period usually occurs from December through June or July, with a mean flow of from 1,000 to 6,000 c.f.s. From June through November the flow is generally between 500 and 1,000 c.f.s. (U.S.G.S records.) The temperature was 38° to 41° F. on November 7 and 8, 1938, and 53° to 57° on September 5, 1942. During the summer, glacial silt from Mt. Adams makes the water turbid in the 60 miles below the West Fork. The gradient is moderate to fairly steep and fast water and rapids are encountered frequently. The lower reaches of the stream flow for several miles through a steep-walled canyon. Between 1 1/2 and 2 miles above the confluence with the Columbia this canyon is constricted and the stream flows through a narrow canyon only about 15 to 20 feet wide. Passage of fish through this gorge is exceedingly difficult. At one point there is a series of five falls and here the Klickitat Indians have fished with spears and dip nets since before the coming of the white man. There is no spawning area below these falls, but in the 27 miles immediately above there are spawning areas sufficient to accommodate an estimated 7,000 pairs of adult chinook salmon.

There are similar areas of spawning rubble in the next 20 miles to the confluence with Big Muddy Creek. Most of the watershed above the latter tributary is in the Yakima Indian Reservation and probably will remain forested and unpolluted for a long time to come. For 8 miles above Big Muddy Creek the river has no extensive spawning areas, but in the next 2 1/2 miles to the confluence of the West Fork there are some fair spawning riffles. Above the West Fork there are some excellent spawning and rearing areas, but most of these are inaccessible due to several falls and cascades, and two log jams. The lowest of

these obstructions is 1/2 mile above the mouth of the West Fork where the river was about 40 feet wide and the flow approximately 75 c.f.s. All of the observed obstructions could be made passable. Only the first five miles above the West Fork were inspected, but detailed survey of the upper portion of the watershed should be made if and when improvements are contemplated. With possible improvements, the Klickitat and its tributaries would have spawning areas for at least 50,000 to 75,000 salmon.

There are 4 small dams located between 10 and 13 miles above the mouth, each diverting 8 to 15 c.f.s. for irrigation purposes. None of the diversions were screened. A large reclamation project is now being considered that would dam the upper Klickitat and divert water through new channels and tunnels to the Simcoe Reservoir and Ahtanum Creek of the Yakima River system. Such a project would cut off some of the better available and potential spawning areas and might make passage for fish more difficult in the river below the dam.

According to reports, there was originally a large run of spring chinook in the Klickitat River, but the run in recent years has been very much smaller. It was stated by many of the older residents of the region that it has been about 30 years since any really large number of salmon has reached the upper sections of the river. A fairly good run of spring steelhead has been reported, and some cutthroat trout are reported in the fall. Apparently there has never been a run of fall chinook into the Klickitat, probably because the falls and cascades in the lower gorge are too difficult to pass during the low water stages in the fall months. It is not improbable that these falls and cascades are more difficult now than formerly, even to spring-run fish, because the flow in the vicinity of the falls is now apparently subject to greater fluctuations. The change in the stream flow may have resulted from lumbering operations, irrigation, and other developments in the watershed.

48A. Silvies Creek: This is the largest tributary below the Little Klickitat River. It has an impassable falls a short distance above its mouth, and is of no present value for salmon production.

48B.) Dillacort Canyon Creek:

48C.) Moore Canyon Creek:

48D.) Swale Canyon Creek: These small, intermittent streams were not surveyed, but are believed to be of little value for spawning salmon.

48E. Little Klickitat River, (or Klickitat Creek): (November 7 and 8 1938; Hanavan and Parkhurst.) This stream enters the Klickitat approximately 30 miles above the mouth. The lower 9 miles were surveyed and the remainder should be surveyed if improvements are contemplated on the lower Klickitat. Its length is 35 miles and the width about 45 feet. The flow was 20-25 c.f.s., and the temperature 44° F. This stream is reported to be quite warm during the summer months. It is subject to a rapid run-off, largely because of poor forest cover in its watershed. The gradient is moderate in the lower 5 miles, but is steeper above, and there are numerous cascades and low falls. Approximately 5 miles above the mouth there is a 10 foot falls that is difficult for the passage of fish at any time and is probably a complete barrier at low water stages. The best spawning area is between 2 and 4 miles above the mouth, and it was estimated that there is a total of 14,000 square yards of suitable spawning rubble below the falls, or sufficient to accommodate at least 700 pairs of chinook salmon. Resting pools average 10 per mile. Steelhead are believed to enter the stream but no salmon were reported.

48E-(1) Bowman Creek:

48E-(2) Mill Creek: (November 8, 1938; Hanavan and Parkhurst.) These two streams are small and of little importance in a program of salmon maintenance. Bowman Creek enters the Little Klickitat 1 mile above the mouth and Mill Creek about 4 1/2 miles above the mouth. Both had flows of 5 to 10 c.f.s.

48E-(3) Spring Creek: (November 8, 1938; Hanavan and Parkhurst.) This stream joins the Little Klickitat 5 miles above the mouth but is inaccessible to fish because of a 35 foot falls just above the junction.

48F. Dead Canyon Creek:

48G. Summit Creek:

48H. White Creek: These creeks are each several miles long, but are reported to be nearly dry during the warmer months of the year. They are believed to be of little value to salmon, and were not surveyed.

48I. Outlet Creek: (Inspected September 5, 1942; Parkhurst.) This stream is 9 miles long and joins the Klickitat 38 miles above the mouth. The stream is of no value to salmon because of a 50 foot falls located about a mile above its confluence with the Klickitat. Below these falls the stream is precipitous. About 2 1/2 miles above the falls there is an abandoned sawmill dam. Much of the water of this stream and its tributaries is diverted for irrigation, and the flow at the time of the survey was estimated at only 2 c.f.s.

48J. Elk Creek:

48K. Bear Creek:

48L. Deer Creek:

48M. Bacon Creek:

48N. Dairy Creek: These streams have not yet been surveyed.

48-O. Big Muddy Creek:

48-O(1) Cougar Creek:

48-O(2) Hellroaring Creek: (Inspected September 5, 1942; Parkhurst.) Big Muddy Creek is tributary to the Klickitat River 51 miles above the mouth. It originates at two glaciers high on the slopes of Mt. Adams and is usually turbid with glacial silt. Its length is 10 miles, the flow was approximately 150 c.f.s., and the gradient is steep. A wooden dam diverts part of the flow of this stream and its two tributaries Cougar Creek and Hellroaring Creek into an irrigation ditch running to Glenwood, Washington. This ditch is 8 feet wide, unscreened, and was diverting a flow of about 15 c.f.s. when observed. There is little suitable spawning area in the stream, and its value to salmon is negligible.

48P. Cunningham Creek:

48Q. Surveyor Creek:

48R. Soda Spring Creek: These streams have not yet been surveyed.

48S. West Fork of the Klickitat River: (Inspected September 5, 1942; Parkhurst.) This stream enters the Klickitat River 60 miles above the mouth. It is formed by the union of two branches about 4 miles above this confluence. Its width is about 50 feet, the flow was 200 c.f.s. and the water was turbid. The temperature was 48° F, which was 8° colder than the main Klickitat just above the confluence of the West Fork. The stream was not surveyed in detail, but it is reported that there is a series of impassable falls less than a mile above the mouth, and that although the gradient is steep, there is some spawning area. It is also reported that spring chinook salmon formerly spawned in the West Fork, but it is doubtful if many now reach the stream.

48S-(1) Little Muddy Creek:

48S-(2) Fish Lake Stream: (Inspected September 5, 1942; Parkhurst.) A detailed survey was not made. These two streams join to form the West Fork of the Klickitat River. Little Muddy Creek had a flow of about 50 c.f.s., and the water was turbid with glacial silt. Fish Lake Stream is clear, but the gradient is steep, and conditions are not favorable for salmon spawning. Neither of these streams is considered to be of importance in salmon maintenance.

48T. Swamp Creek:

48U. Chaparral Creek:

48V. Pearl Creek:

48W. East Fork of the Klickitat River:

48X. Huckleberry Creek:

48Y. Piscoe Creek:

48Z. Diamond Fork: None of these upper tributaries has as yet been surveyed

TABLE OF OBSTRUCTIONS AND DIVERSIONS [1/]

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Main Columbia River	Bonneville Dam	55-65	3 Fishways	
Chinook Creek	2 tide gates	--	---	Study to determine need
	Beaver dams and trash jams	3-7	---	Remove or open for spawning runs.
Deep River	Several tide gates	--	---	Study to determine need
Grays River	Cascade & falls	8-10	None	Remove or ladder
Left Fork Grays R.	Log jams	5-10	None	Resurvey
North Fk. Grays R.	Splash dam (Abandoned)	18	None	Survey above and study dam for removal
Mitchell Creek	2 falls	6, 7	None	Blast out passage
South Fork Grays R.	Splash dam (Abandoned)	40	None	Study dam; survey above
	Falls	15	None	Survey above to determine need for improvement.

1/ This list does not include minor cascades, low falls, log and brush jams, etc., that do not interfere with passage of migratory fish. The listed height of falls and dams is the approximate height that fish would have to jump to clear the obstruction at normal water levels; i.e. the distance from tailwater to the crest of the obstruction. Small irrigation pumps are usually screened and are not listed in the table of diversions.

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Crooked Cr.	Irrig. dam & div.	4	None	Screen
	Unused power dam	6-8	None	Remove
Jim Crow Cr.	Brush jams	5-7	None	Remove
Wilson Cr.	Log jam	6-8	None	Remove
Elkhorn Creek	Culvert	--	None	Install baffles
East Fk. Alochoman R.	Log & debris jams	4-9	None	Resurvey & remove jams
Mill Creek	Falls	7	None	Survey above to determine value and need
Abernathy Creek	Falls & cascades	10, 8	None	Install fishways
	12 log jams, (4 difficult, 3 impassable)	4-12	None	Remove
Germany Creek	Log jam and low falls	9	None	Remove
Falls Creek	Falls	40	None	None; too small above
Coal Creek	3 Falls	3-5	None	Reduce by blasting
	Double falls	12+6	None	Survey above to determine value and need

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Kalama River	Falls & Power dam	12, 3	Fishway	Improved larger fishway; inspect diversion and screen if necessary
	Kalama Falls	25-30	None	Survey upper portion of river
Little Kalama River	Falls	5	None	Blast out; survey above
Lewis River	Ariel Dam	240	Fish traps & lift	
East Fork Lewis River	Lucia Falls	14	None	Construct fishway
	8 falls	4 to 9	None	Blast out or ladder
	Horseshoe Falls	18	None	Construct fishway
	2 log jams	20, 10	None	Remove or keep passable
	Sunset Falls	16	None	Survey above
Rock Creek (26A-5)	Falls	5	None	Blast out
Copper Creek	Falls	18	None	Survey above

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Cedar Creek (26B)	Falls	7-10	None	Improve passage
	Culvert		None	Install baffles
	Beaver dams & jams	3-6	None	Remove or breach at spawning periods
Salmon Creek (27)	3 beaver dams and 3 log and debris jams	3-8	None	Remove or breach during spawning runs. Remove log jams
Mill Creek (27B)	Brush jam	7-10	None	Remove
Washougal River	Salmon Falls	8	None	Fishway
	Washougal Ranger Sta. falls	25	None	Survey above
	8 falls and cascades	7-15	None	Survey above
Lacamas Creek	Falls	70	None	None
	Camas Paper Co. dam	30	None	None

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Little Washougal River	Sawmill dam	18	None	Breach or remove
	Camas Water Co. dam	4	None	Survey above
Canyon (or Cougar) Cr.	2 falls	15, 15	None	None
West Fk. Washougal R.	Falls	18	None	Survey above
Texas Creek	Falls	9	None	Survey above
McCloskey Creek	Falls	8-10	None	Survey above
Dougan Creek	Falls	Impassable	None	None
Stebbins Creek	Falls	Impassable	None	Inspect above
Prospector Creek	Falls	28	None	None
Hardy Creek	Rodney Falls	Impassable	None	None

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Hamilton Creek	Falls	8	None	Survey above at spawning time
Rock Creek	Series of 7 falls	65	None	None
	Falls	25	None	None
Nelson Creek	Falls	Impassable	None	None
Carson Creek	Falls	Impassable	None	None
Wind River	Shepard Falls	4, 13, 12	None	Construct fishway
	Cascades and falls	4-10	None	Fishways, or reduce by blasting
Little Wind River	Falls; log jams	8	None	Remove worst log jams below falls.
Bear Creek	Falls	18	None	Survey above falls

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Panther Creek	Log jams; 4 falls	5 to 10	None	Remove log jams below falls
Cedar Creek (40D-1)	3 log jams	6, 9, 5	None	Remove log jams and survey above
Trout Creek	Forest Service dam	20	Fishway	None, if ladder is operated properly
	Forest Service dam	5	Fishway and screen	None
Trapper Creek	Debris jams	6	None	Remove
Falls Creek	Falls	Impassable	None	None
Collins Creek	Falls	Impassable	None	None
Dog Creek	Falls	Impassable	None	None
Little White Salmon River	Falls	37	None	Survey above
White Salmon River	Northwestern Elec. Co. dam	100	None	None at present

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Catherine Creek	Falls	10	None	None
Major Creek	Falls	10	None	None
Klickitat River	5 Falls (lower gorge)	6, 6, 4, 7, 14	None	Fishways
	5 cascade falls and impassable log jams above West Fork		None	Survey all above lower 30 miles
Silvies or Silvia Cr.	Falls	Impassable	None	Survey
Little Klickitat River	Falls	10	None	Survey above
Spring Creek (48B-3)	Falls	35	None	None
Outlet Creek	Falls	50	None	None
	Mt. Adams Sawmill dam (abandoned)	8	None	None
Big Muddy Creek	Irrigation dam	?	None	None
West Fork of the Klickitat River	Series of 4 falls	29 (total)	None	Survey stream

PART 2

SUB-AREA COWLITZ RIVER

CONTENTS

	Page
Map of Sub-area Cowlitz River ..... opposite	52
List of streams	53
The survey	60
Description of streams	61
Obstructions and diversions	100

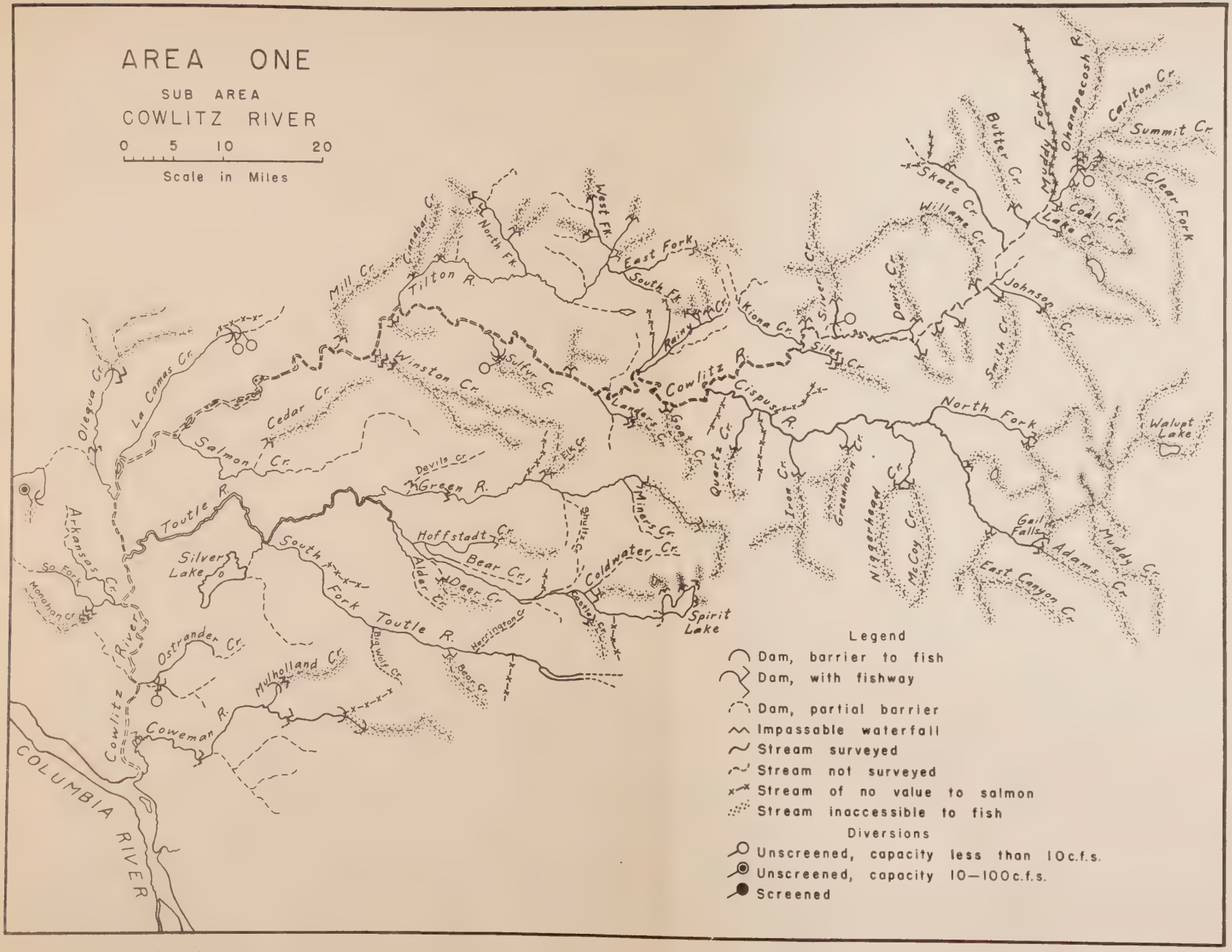


Figure 6. Stream Survey Sub-area Cowlitz River.

LIST OF STREAMS [1/]

		Page
17	Cowlitz River	61
	A Coweman River	62
	(1) Goble Creek	63
	(2) Mulholland River	63
	(3) Baird Creek	63
	B Ostrander Creek	63
	(1) South Fork of Ostrander Creek	64
	C Arkansas Creek	64
	(1) North Fork of Arkansas Creek (or Dobson Creek)	65
	a. Baxter Creek	65
	(2) South Fork of Arkansas Creek (or Scantigrease Cr.)	65
	a. Monahan Creek	65
	D. Toutle River	66
	(1) Outlet Creek	67
	(2) South Fork of Toutle River	67
	a. Unnamed Creek	68
	b. Unnamed Creek	68
	c. Johnson Creek	69
	d. Jordan Creek	69
	e. Thirteen Creek	69
	f. Eighteen Creek	69
	g. Twenty Creek	69
	h. Big Wolf Creek	69
	i. Whitten Creek	69
	j. Bear Creek	69
	k. Harrington Creek	69
	l. Trouble Creek	69
	m. North Branch	70
	* i. Disappointment Creek	
	n. South Branch	70

1/ Those streams marked with an asterisk are unsurveyed minor tributaries with a barrier or fluctuating flow. They are not described in the text but are retained for check list purposes.

Page

(3) Middle Fork of the Toutle River 70
(4) Green River 70

a. Devils Creek 71
b. Cascade Creek 71
c. Elk Creek 71
d. Shultz Creek 71
e. Trade Dollar Creek 72
f. Miners Creek 72

(5) Alder Creek 72
(6) Hoffstadt Creek 72

a. Bear Creek 73
b. Cow Creek 73

(7) Deer Creek 73
(8) Jackson Creek 74
(9) Elk Creek 74
(10) Mirada Creek 74
(11) Castle Creek 74
(12) Coldwater Creek 75

a. South Fork of Coldwater Cr. 75

(13) Studebaker Creek 76
(14) Spirit Lake 76

a. Bear Creek 77
b. Margaret Creek 77
c. Unnamed Creek .....
d. Harmony Falls Creek 77
e. Cedar Creek 77
f. Donnybrook Creek 77

E. Olequa Creek 77

(1) Stillwater Creek 78

a. Brim Creek 78

* i. North Fork

b. Campbell Creek 78

i. Decker Creek 79

(2) Unnamed Creek 79
(3) Ferrier Cr. 79

Page

F. La Camas Creek 79

(1) Ayell or Bear Creek 80

G. Salmon Creek 80

(1) Little Salmon Creek 80
(2) Cedar Creek 80

* a. North Fork

H. Mill Creek (or Hurd Cr.) 80
I. Winston Creek 81
J. Klickitat Creek 81
K. Tilton River 81

(1) Cinnabar Creek 82
(2) Bear Canyon Creek 82
(3) Alder Creek 82
(4) North Fork of the Tilton River 82

a. Jefferson Creek 82
b. Bromo Creek 82
c. Fisher Creek 83
d. Wallanding Creek 83
i. Tumble Creek 83
e. Otter Creek 83
f. Rockies Creek 83
g. Jesse Creek 83
h. Winnie Creek 83

(5) Highland Creek 83
(6) Davis Lake Creek 83
(7) Connelly Creek 84
(8) Mines Creek 84
(9) East Fork of the Tilton River 84

a. South Fork of the East Fork 84

(10) Nineteen Creek 84
(11) West Fork of the Tilton River 85

a. Coon Creek 85

i. Snow Creek 85

b. Eagle Creek 85

i. Trout Creek 85
ii. Soos Creek 85

Page

L. Sulphur Creek 85
M. Shelton Creek 86
N. Landers Creek 86

(1) Wakewasis Creek 86

O. Sand Creek 86
P. Staffen Creek 86

(1) Uden Creek 87
(2) Frost Creek 87

Q. Rainy Creek 87

(1) Lunch Creek 87

a. East Fork of Lunch Creek 88

(2) North Fork of Rainy Creek 88

R. Peterson Creek 88
S. Goat Creek 88
T. Tumwater Creek 88
U. Cispus River 88

(1) Copper Canyon Creek 89
(2) Quartz Creek 89
(3) Crystal Creek 90
(4) Woods Creek 90

* a. Ames Creek

(5) Iron Creek 90
(6) Nash Creek 90
(7) Falls Creek 90
(8) Greenhorn Creek 90
(9) Stump Creek 90
(10) Dry Creek 90
(11) Niggerhead Creek 91

a. Highbridge Creek 91
b. Lambert Creek 91
c. Galena Creek 91
d. McCoy Creek 91

(12) Camp Creek 91

Page

(13) North Fork of the Cispus River 91

a. Tyler Creek 92
b. Polk Creek 92
c. Irish Creek 92
d. Swede Creek 92
e. Midget Creek 92
f. Jackpot Creek 92
g. Siwash Creek 92
h. Yozoo Creek (or Yoxoo Creek) 92
i. Timonium Creek 92

(14) Horse Creek 92
(15) Smoothrock (or Slickrock) Creek 92
(16) Blue Lake Creek 92
(17) Juniper Creek 92
(18) East Canyon Creek 92
(19) Squaw Creek 92
(20) Adams Creek 92

a. Sheep Creek 93

(21) Orr Creek 93
(22) Cat Creek 93
a. Mouse Creek .....

(23) Muddy Fork of the Cispus River 93

* a. Spring Creek

(24) Pimlico Creek 93
(25) Midway Creek 93
(26) Wesley Creek 93
(27) Elk Creek 93
(28) Chambers Creek 93
(29) Walupt Lake Creek 93
(30) Goat Creek 93

V Schooley Creek 93
W Siler Creek 93

(1) Squire Creek 93

X Kiona Creek 93

(1) Peters Creek 94
(2) Oliver Creek 94

Page

Y Mill (or Miller) Creek 94
Z Silver Creek 94

(1) East Fork of Silver Creek 94

AA Purcell Slough 95

(1) Hopkins Creek 95

BB Davis Creek 95
CC Cunningham Creek 95
DD Owens Creek 95
EE Cougar Creek 95
FF Kilborn Creek 95
GG Garret Creek 95
HH Burton Creek 96

(1) East Fork of Burton Creek 96

II Willame Creek 96
JJ Dry Creek 96
KK Smith Creek 96
LL Johnson Creek 97

(1) Glacier Creek 97
* (2) Deception Creek
* (3) Middle Fork of Johnson Creek
* (4) Mission Creek
* (5) Jordan Creek

MM Hall Creek 97

(1) Hager Creek 97

NN Skate Creek 97

(1) Dixon Creek 98
(2) Boulder Creek 98
(3) Teardrop Creek 98
(4) Rock Creek 98
(5) Johnson Creek 98

OO Butter Creek 98
PP Lake Creek 98
QQ Muddy Fork of the Cowlitz River 98
RR Cole (or Coal) Creek 99
SS Purcell Creek 99

Page

TT Clear Fork of the Cowlitz River 99

(1) Dam Creek 99
(2) Cartright Creek 99

UU Ohanapecosh River 99

THE SURVEY

The Cowlitz River is second in size only to the Willamette River of all the streams tributary to the Columbia River below Bonneville Dam. It has a drainage area above the lower 14 miles of 2,240 square miles, and an average discharge of 8,443 second-feet. (U.S.G.S. Water Supply paper No. 984). Excluding the lower few miles, it and its many tributaries drain a rugged hilly country whose general inaccessibility allows little interference with the spawning salmon. The region is not adapted to farming on a large scale, and therefore there are few large towns along the river's course. This is a decided advantage as far as potential salmon production is concerned, for there has not been, and probably never will be any really great demand for large scale irrigation or flood control projects. With private power and Bonneville power available to the entire area there should also be little need for large power dams in the future.

Nevertheless there have been several large projects proposed for this river system, among them being two high dams by the City of Tacoma on the main Cowlitz and an irrigation dam and diversion proposed by the U. S. Bureau of Reclamation for the Tilton River, one of the larger and better salmon and steelhead producing tributaries. There are also two multiple-purpose dams listed for the Main Cowlitz River by the U. S. Army Engineers. With the huge upper and mid-Columbia power and irrigation expansions being made, it is felt that the streams in the Cowlitz system are of sufficient importance to present and future fish production to warrant a close scrutiny of all such proposed projects that would interfere with the migration of fish in this area. Unless urgent need for them can be shown, a vigorous opposition to them may be expected from conservation, commercial and sports fishing organizations. The Cowlitz River system may very well be one of the future top ranking salmon and steelhead breeding areas in the country. Its future is rendered brighter by the fact that, since lumbering operations have been concluded on much of its watershed, the blocking and damaging of the streams is therefore mostly in the past, and rapid regrowth should progressively check erosion and gradually increase the minimum stream flows.

The ruggedness of the terrain however has also provided one or two detrimental features for the streams in this system; namely the waterfalls and cascades that block some of the streams, and the steep gradients of most of the smaller streams that greatly reduce their value to spawning salmon and steelhead. However, the survey has determined that most of the smaller and steeper streams that at first had been considered valueless, actually had small spawning areas near their mouths, and that these areas were often used to the fullest extent by silver salmon and steelhead. It is therefore necessary to include them all in a survey report on the area.

This river system is the greatest silver salmon producing area in the entire Columbia River watershed. Silver salmon fingerlings in large numbers were observed by the survey parties all along the margins of the main Cowlitz and in nearly every accessible tributary. It is also one of the more important spawning areas for fall run chinook salmon and steelhead trout as well as for spring chinook salmon. Some chum salmon use its lower tributaries, and the Cowlitz smelt run is famous.

The stream survey parties surveyed in detail a total of 82 streams in the Cowlitz system and inspected less completely scores of the smaller tributaries. The surveyed streams had an aggregate length of 794 miles, of which 404 miles have been surveyed. The surveys were usually stopped on reaching an insurmountable barrier in a stream. In the 404 miles surveyed there was a total bottom area of 9,780,000 square yards below barriers and accessible to salmon, and an additional 660,000 square yards above barriers and inaccessible at present. It is estimated that there is accessible and suitable spawning area for at least 75,000 pairs of salmon below barriers, and spawning area for at least 7,000 more pairs is known to exist above barriers, but is inaccessible at present. The above figures do not include any spawning area on the main Cowlitz River, which has not yet been thoroughly surveyed because it is usually so clouded with glacial silt that observations are possible only for short periods during the winter or early spring.

DESCRIPTION OF STREAMS

17. Cowlitz River: (July 29, 1937; Hanavan, Baltzo, Kolloen and Lobell.) This river joins the Columbia about 65 miles above the mouth, at Longview, Washington, and is one of the largest tributaries in the State of Washington. Formed by the confluence of the Clear Fork and the Ohanapecosh River, the main Cowlitz is about 130 miles long. Its maximum flow was 139,000 c.f.s. on December 23, 1933. Its minimum flow was 998 c.f.s. on November 7 and 8, 1935, and the average discharge is 8,443 c.f.s. (U.S.G.S. records at Castle Rock, Washington). Its headwaters include streams from glaciers on Mt. Rainier, Mt. St. Helens and Mt. Adams, and while this assures an adequate flow of water during the summer months, the river is usually so turbid with rock flour and glacial silt that visibility in the water is reduced to a few inches. Because of this condition, only the upper 1 1/2 miles between the Muddy Fork and the Clear Fork have been surveyed in detail, although other areas have been visited at various times by members of the survey staff. Lying in a broad valley that is regularly flooded in the spring, the lower Cowlitz is so wide and deep that tug boats are able to tow log rafts to a point above Castlerock, some 20 miles above the mouth. In its midsection it flows through a deep rocky canyon, at the head of which, about 90 miles above the mouth and just below the mouth of the Cispus River, there is an 8 foot falls that is passable with difficulty and should be removed. The pools below the falls were formerly favorite sports fishing and snagging places for salmon, steelhead, and sea-run cutthroat trout.

The main stem of the Cowlitz is primarily of importance as a migration route of anadromous fish. There is, however, considerable spawning area in the main stem for both chinook and silver salmon.

17A Coweman River: (September 20-22, 1936; Suomela and Jobes. Lower 18 miles inspected October 5, 1945; Silliman.)
This stream enters the Cowlitz River 1 mile above the mouth, near Kelso, Washington. It is 33 miles long and 25 1/2 miles were surveyed. It was 90 feet wide, and had a flow of 50 c.f.s. during the very low water period of 1936. Resting pools average 10 per mile, and the water temperature was between 50° and 61° F. A measured flow of 84 c.f.s. and a temperature of 50° F. was obtained by Silliman on Oct. 5, 1945 at a point 7 1/2 miles above the mouth. Pollution in the form of domestic sewage and barnyard waste was found, but was not in sufficient quantities to affect fish. In its lower 4 miles the river flows through dyked lowlands, is usually turbid and, since much of the bottom consists of mud and sand, there is little available spawning area, especially in the lower 2 miles. The next 11 miles are in a rather narrow valley that is canyon-like at intervals and has a moderate gradient. The most extensive spawning areas are in the 8 mile stretch below the confluence of Mulholland Creek. In the upper 10 miles surveyed the valley is much narrower, the gradient steeper, and the spawning areas are of decreasing size and value, although there are good riffles found throughout most of the stream. A low falls 5 miles up stream, and another at 12 miles are reported to hinder fish movements and should be eliminated. Twenty miles upstream, and 3 miles above the confluence of Mulholland Creek there is a 9 foot falls that is a low water barrier. Since this limits the migration of spawning salmon in the fall of the year, it should be made passable. There is spawning area available below this falls for at least 5,000 pairs of salmon. Upstream 23 1/2 miles there is an abandoned splash dam-38 feet in height that is a total barrier, and a second similar abandoned dam is located less than 2 miles farther upstream. There are spawning areas that could be made available between the 9 foot falls and the first dam for at least 400 pairs of salmon. The remainder of the main river and its tributaries should be surveyed, and the dams studied to determine the best method of making them passable. A good run of fall chinook still uses this river, as does a small run of silver salmon. A run of steelhead is reported, and a few chum salmon are said to utilize the lower portion, but the available spawning areas are definitely underpopulated at present. Four hundred and seventeen fall chinook and 2 silver salmon were counted below the falls by the 1936 survey party, and 40 live and 1726 dead salmon, nearly all of which were believed to be fall chinook, were counted in a 16 mile stretch below the falls on October 5, 1945, by R. P. Silliman.

17A-1 Goble Creek: Tributary to the Coweman River 7 1/2 miles above the mouth. No data were obtained on this 6 mile long stream except a report of a dam 3 1/2 miles above the mouth. It should be surveyed.

17A-2 Mulholland Creek: (September 23, 1936; Suomela and Jobes.) Enters the Coweman River approximately 16 miles above the mouth. It has a total length of 7 1/2 miles, of which the lower 1 3/4 miles were surveyed to an impassable 30 foot splash dam. The stream width is 45 feet, its average depth 6 inches, its gradient moderate to fairly steep, the water level fluctuation 10 to 12 feet, and the water temperature was 54° F. There were no diversions or pollution noted. An 11 foot high falls 1 5/8 miles above the mouth is a low-water barrier and difficult to pass at any time. Debris jams are present in the stream. There is a preponderance of bedrock and rubble that is too large for good spawning use, and such spawning areas as do exist are usually confined to small patches. A small run of fall chinook enter the river, but only 3 were seen by the survey party. No reports could be obtained on a possible steelhead run. The stream has little known value to salmon. A survey should be made of the remainder of the stream to see if it is of sufficient value to warrant removal of the barriers.

17A-3 Baird Creek: (September 23, 1936; Suomela and Jobes.) This small stream enters the Coweman River 23 miles above the mouth. It is 5 miles long and had a flow of 1 to 2 c.f.s. The lower portion lies in a flat meadow and has a mud and sand bottom but the upper section is very steep and there is only a small amount of spawning rubble. Although the stream is probably of little importance, it should be surveyed during spawning periods. A dam is reported approximately 1 mile above the mouth.

17B Ostrander Creek: (October 31 - November 1, 1936; Baltzo and Jobes.) This stream, tributary to the Cowlitz River approximately 7 miles above the mouth, is 10 miles long, of which the lower 7.2 miles were surveyed. The lower 2 miles are bordered by farm lands, and the remainder by brush covered hills. The gradient is moderate but a freshet rise of 3 to 5 feet is indicated by debris on the banks. At extreme low water the flow was 4 c.f.s. at a point 1 mile above the mouth, and 2.2 c.f.s. at the terminus of the survey. Pollution in the form of domestic and barnyard wastes occurred at intervals, but apparently did not affect fish. Water temperatures were between 38° and 49° F. and resting pools average 22 per mile. An irrigation dam located 1.6 miles upstream formed a low water barrier, but this obstruction has since been reported to have been removed. There are 3 cascades between 2.3 and 3 miles above the mouth that are low water barriers, and difficult to pass at other times. Also present are 22 beaver dams, 7 of which are low water barriers, and 10 log jams. The latter may be barriers at times, as no passage for fish could be found through them. This series of barriers has rendered all but the lower

2 1/3 miles of the stream inaccessible to spawning salmon. The bottom in the lower 1/2 mile is of mud and sand. There is spawning area above for at least 500 pairs of salmon, the best areas being located between 1/2 and 2 miles above the mouth, and in the upper 2 miles surveyed. The mid section has mainly large rubble. Small runs of dog salmon (not verified) and silver salmon are reported to enter the creek in the fall. Fair runs of fall cutthroat and steelhead trout are also present.

17B-(1) South Fork of Ostrander Creek: (October 31, 1936; Baltzo and Jobes.) Tributary to Ostrander Creek about 3/4 miles above the mouth, the stream is 6 miles long and the lower 2 miles was surveyed. The watershed has been logged, and is now covered with brush. A diversion dam 2 feet high is located 300 yards above the mouth. This diverts all or nearly all of the water during low water periods for a sawmill pond and for the domestic water supply of the town of Ostrander, Washington. Fish have been reported in the pond. The unscreened diversion flume is a real hazard to downstream migrating fingerlings, and should be screened. There is a log and debris jam a short distance farther upstream and an 8 foot falls 0.6 miles above the mouth is a total barrier except during short periods of high water in the spring. There are numerous beaver dams that form low water barriers in the upper portion of the stream. A few fingerling salmon were seen in a pool near the mouth and a small run of dog salmon is reported to spawn below the falls when there is enough water permitted to pass the dam. A few sea-run cutthroat are also reported in the fall. A flow of only 2.2 c.f.s. was measured near the mouth, during the abnormal low water that prevailed at the time of the survey. Until the barriers are removed or by-passed and a constant flow of water maintained, the stream is of little value to migrating fish. There was sufficient spawning area observed for about 100 pairs of salmon in the section surveyed.

17C Arkansas Creek: (May 22, 1937; Hanavan and Lobell.) This stream enters the Cowlitz about 15 miles above the mouth near Castle Rock, Washington. Formed by the confluence of the North and South Forks, the main Arkansas is only 2 miles long and was all surveyed. It flows through a wide valley dotted with farms, and is entirely slough-like, with a mud and sand bottom of little or no value to salmon and trout. It is 60 feet wide and several feet deep. Heavy seasonal rains draining into its tributaries cause a fluctuation in water level of 8 to 10 feet. There were no barriers or diversions, and the only pollution was a small amount of domestic sewage and barnyard waste. The water temperature was 52° F. Silver salmon and steelhead run through it to spawn in its tributaries. Fall chinook have been reported. Its numerous deep pool and eddy sections are afforded good protective cover. These sections are ideal nursery grounds, and numerous silver salmon and steelhead fingerlings were observed feeding in them.

17C-(1) North Fork of Arkansas Creek or Dobson Creek: (May 24, 1937; Hanavan and Lobell.) Approximately 6 1/2 miles of its total length of 10 miles were surveyed. The lower 3 miles of this branch flows through a flat lowland between earth banks 10-15 feet high, and has a mud and sand bottom of little value to spawning salmon. The gradient increases in the next 2 1/2 miles, and in this stretch there is spawning gravel for at least 500 pairs of salmon. Several brush jams are difficult to pass, and a log jam at the end of the survey was believed to be impassable, except perhaps during brief flood periods. The hills in the upper watershed have been denuded by logging operations, and uninhibited surface run-off has caused considerable erosion, which in turn has caused silting of the spawning beds with detrimental effects on fish production. The stream could be improved by opening the brush and log jams. A small run of silver salmon and steelhead is reported, and silver fingerlings were observed. There also may be a few fall chinook. Baxter Creek is the chief tributary. It had a flow of 3-4 c.f.s., but is too precipitous to be of much value to fish.

17C-(2) South Fork of Arkansas Creel or Scantigrease Creek: (May 22-23, 1937; Hanavan and Lobell.) About 7.3 miles of a total length of 9 miles were surveyed. The stream is similar to the North Fork, but the watershed erosion is less severe, and silting of the spawning beds is much less extensive. A flow of 17 c.f.s. was recorded 3 1/2 miles above the mouth. Resting pools average 26 per mile and the water temperature was 55° . The lower third of the stream is clough-like and of little value, but the middle third has a moderate gradient and some excellent spawning riffles. There were no dams, diversions or pollution. In the lower 3 miles a total of 6 log and brush jams were found. These jams were believed to be passable with some difficulty at most water stages, but should be removed. A good run of silver salmon and steelhead exists, and a large number of fingerlings of both species were seen. The stream appears to be a good salmon producer, with a greater potential value than the North Fork, and could accommodate at least 1,000 pairs of fish.

17C-(2)a Monahan Creek: (May 24, 1937; Lobell.) Joins the South Fork about 2 miles above the mouth. The total length is 7 miles; the lower 1/2 mile was surveyed to a series of 3 cascade falls with a combined height of 18 feet that is impassable to fish. The stream was 20 feet wide, and had a flow of 15 c.f.s. Silver salmon spawn below the falls and fingerlings were observed. Since there is additional spawning area above the falls, the remainder of the stream should be surveyed to determine whether the falls should be made passable. Resident trout are present and the stream is well fished by sportsmen.

17D Toutle River: (September 13-19, 1936; Hanavan, Whiteleather, Suomela and Jobes. Inspected at various points 1940-43 by Bryant, Parkhurst, Frey, and others.) This large stream flows 52 miles from its point of origin in Spirit Lake to its confluence with the Cowlitz River about 17 miles above the mouth of the latter, and has been completely surveyed. A few older maps designate the portion above the mouth of the South Fork as the North Fork. The drainage area of the two forks is 474 square miles. The river is 135 feet wide and 4-5 feet deep at its mouth, and about 25 feet wide below the Spirit Lake outlet. The gradient averages 20 feet per mile for the lower 15 miles, and gradually increases to an average of 151 feet per mile in the upper 8 miles. A constant water supply is assured by melting snow on Mt. St. Helens, and lake storage. A mean flow of 1700 to 4500 c.f.s. occurs from December to May, with the flow from June through November usually being between 350 and 700 c.f.s. (U.S.G.S. records.) The watershed is hilly and mountainous, and has been logged off except in the upper portions. Logging operations are still being conducted below the Columbia National Forest boundary. A fluctuation in water level up to 20 feet occurs in the narrower channels, the run-off being accellerated by dredging, channel straightening, and the removal of log jams. This has been done to prevent damage to the highway and bridges. Resting pools average only 3 per mile. Water temperatures were between 48° and 54°. On March 15, 1944, the following water temperatures were recorded: 41° and 38.6° at the two lower highway bridges, 42.5° just above Alder Creek, 40° above Studebaker Creek, and 35° at the outlet of Spirit Lake. No pollution or diversions were found, and the only obstacles to the movement of fish in the river are 2 small dams just below the lake outlet. The upper rock and earth filled dam, known as Coe dam, is only about 2 feet high. The stream had cut a channel around one end of the dam, but when it was examined in September 1940 by Parkhurst and Bryant, it was found that the channel was blocked by large boulders and rock fill from recent highway construction. At low water stages it was a barrier to upstream migrating salmon since all of the water was seeping through crevices too small for such fish to get through. It is not a barrier during high water periods, for steelhead were observed spawning in small tributaries to the lake in the spring of 1941. Both dams should be breached, provided with fish ladders, or removed entirely. A log jam below the lake should also be removed. There is spawning area in the main Toutle River for many thousand salmon and, unlike many of the larger Columbia River streams, the main stream is used to a considerable extent for spawning. In the more rapid sections spawning is confined to patches below large boulders, but extensive spawning areas in the lower mile near the mouth of Outlet Creek, and in the vicinity of Coal Bank bridge are still utilized in part, mostly by fall chinook, as are other random areas to the confluence with Deer Creek about 32 miles above the mouth. The section from Deer Creek to about 5 miles below the outlet at Spirit Lake is heavily charged with

glacial silt in the late summer and early fall months and no spawning was observed there, although the section was checked for spawning in 1938. With reasonable deduction for the unfavorable effect of swift current, and deep stretches, it is believed that there is spawning area in the main river alone for at least 5,000 to 10,000 pairs of salmon. Silver salmon are said to spawn mainly in the first 2 miles below the dam in the lake outlet. Former runs of chinook, steelhead and silvers were reported to have been large. At present there are comparatively small runs of fall chinooks and silvers. A small run of spring chinooks are known to spawn in some tributaries, notably Coldwater Creek. Steelhead spawn in the tributary headwaters in the spring. Reduction of the former runs may have been due in part to logging activities and sport fishing. With logging operations now confined to the upper tributaries, a rehabilitation program seems possible.

17D-(1) Outlet Creek: (September 14, 1936; Hanavan and Whiteleather.) Enters the Toutle River 12.7 miles above the mouth, and extends for approximately 2 miles to its source in Silver Lake. The lower 1 3/8 miles was surveyed. Its valley is narrow and canyon-like, and surrounded by brush-covered, burned and logged-over land. The stream is 11 to 21 feet wide, has a moderate gradient, and the flow is determined by the level of Silver Lake except during periods of heavy rains. Silver Lake is bordered by acres of lily pads and is populated by bass and other warm water fishes, although a few trout are also reported. Suitable spawning rubble is present in the creek but, due to the small size of the stream, it is only sufficient for a few salmon. No pollution, dams, or diversions were found. A log jam 300 yards above the mouth would be very difficult to pass, except during high water, and should be removed. A few silver salmon are said to use the stream, but none were seen.

17D-(2) South Fork of the Toutle River: (May 22-27, 1941; Frey and Bryant.) Enters the main Toutle about 13 miles above the mouth. Twenty three miles were surveyed of the total length of 28 miles. The drainage area is 120 square miles. The maximum discharge was 6,770 c.f.s. on December 19, 1941, and the minimum discharge of record was 68 c.f.s. on August 18 and 19, 1940 (U.S.G.S. records). The stream is 80 to 90 feet wide in the lower 5 miles, and 9 feet wide in the upper few miles. Its gradient averages 55 feet per mile in the lower 15 miles, increases to over 120 feet per mile in the mid section, and is over 500 feet per mile in the upper 4 miles. Water temperatures were between 46° and 59° F., with a diurnal fluctuation of 11° F. observed. A temperature reading of 42° F. was obtained near the mouth on March 15, 1944. All of the watershed except the upper section has been logged. The only habitations are in the lower 3 miles, and there are no roads, or even good trails above that point.

It is believed that in some years salmon may pass over much of the spawning area in the lower 2-4 miles, continuing their migration to spawning areas farther upstream, since water temperatures somewhat high for salmon may occur in this lower section in the summer and early fall of some years. A 9 mile stretch of canyon beginning about 5 miles above the mouth is inaccessible to fishermen except at low water periods. In this canyon there is a succession of well protected deep resting pools averaging 15 per mile. Excellent spawning areas are present at the lower edge of each pool and at the head of the riffles below. The current at the lower ends of the riffles is invariably too rapid for spawning. There is additional spawning in the next 6 miles above the canyon to a forks, but the resting pools are much smaller. The upper 4 miles surveyed were on two branches following changeable courses through an outwash rubble plain at the foot of Mt. St. Helens. The rolling stones and general unstability of the rubble in this section make it unfavorable for successful spawning, and even native trout were not found there, although they may be present during the summer months.

Small runs of fall and spring chinook were reported, but no salmon were seen by the survey party, although it was probably too early for adult spring chinooks. A small run of steelhead is present, and 9 adult spawners were counted in the canyon section, while others may have been present in the deep pools. Rainbow trout of all sizes were seen in the lower 16 miles, and cutthroat are reported. The total bottom area was estimated to contain 625,000 square yards of which 92,000 square yards was suitable spawning rubble. This is enough for several thousand salmon, and very little of it is utilized by the present small runs. The watershed has already been logged, the stream is well removed from the influence of civilization, and there is neither pollution nor obstructions. The present value of its fine holding pools and spawning riffles can therefore be maintained without additional improvement costs so that the stream presents a splendid opportunity for restocking on a large scale.

The following tributaries were inspected on May 22-27, 1941, by Frey and Bryant, and found to have little value to spawning steelhead and salmon. A few steelhead and silvers however may spawn near their mouths. Mileage given is the distance of their confluence above the mouth of the South Fork. Other tributaries with a flow of less than 1 c.f.s. are not listed.

17D-(2)a Unnamed Cr.: Enters 1/2 mile up; is 5 miles long; and should be surveyed at spawning time.

17D-(2)b Unnamed Cr.: Enters 500 yards below Johnson Creek. It was 7 feet wide and had a flow of 3-5 c.f.s., but would probably be too low for use by salmon later in the season.

17D-(2)c Johnson Creek: Enters 3 1/2 miles upstream and had a flow of 15 c.f.s. Its channel is badly choked with logging debris and it is of little value in its present condition. It might be improved.

17D-(2)d Jordon Creek: Enters 5 miles upstream and is about 15 feet wide at its mouth, and had a flow of about 15 c.f.s. The bottom near the mouth was largely of bedrock and sand, but the stream should be surveyed.

17D-(2)e Thirteen Creek: Enters approximately 6.7 miles upstream, is 8 feet wide and had a flow of 10 c.f.s. It enters from a narrow, steep-walled valley, and has a series of boulder cascades near its mouth. Very little of this stretch could be used by salmon. It should be surveyed farther upstream.

17D-(2)f Eighteen Creek: Enters 7 miles upstream and had a flow of 5 to 8 c.f.s. This stream is blocked by an impassable falls 50 yards above its mouth.

17D-(2)g Twenty Creek: Enters 8.2 miles upstream, is 6 to 7 feet wide, had a flow of 5 c.f.s. An impassable falls 6 feet high is located 50 yards above its mouth. The stream should be surveyed above the falls.

17D-(2)h Big Wolf Creek: Enters the South Fork 400 yards above the mouth of Twenty Creek. It is 6 feet wide, had a flow of only 5 c.f.s., and is probably of little value to salmon; but should be surveyed.

17D-(2)i Whitten Creek: Enters 12 miles up, is similar in size to Big Wolf Creek, but is blocked by an impassable 30 foot falls 250 yards upstream.

17D-(2)j Bear Creek: Enters 13.3 miles upstream at the head of the canyon on the South Fork. It is blocked by an impassable falls 10 feet high, located 460 yards above the mouth, and has little accessible spawning area. Its flow was 15 to 20 c.f.s.

17D-(2)k Harrington Creek: Enters 14.4 miles upstream and is about 6 feet wide. It is too small and shallow to be of any value except possibly for a few fish near its mouth.

17D-(2)l Trouble Creek: Enters 16.3 miles upstream. It was ten feet wide and had a flow of 15 c.f.s. The gradient in the lowest 1 1/2 miles is about 350 feet per mile. It was surveyed for 500 yards and found to be too steep and to have too much large rubble to be of any real value to salmon.

17D-(2)m&n North and South branches: Included in the main report on the Toutle River each branch is 10-20 feet wide, but much of the bottom rubble is unstable and unsuited for spawning. The lower portions might support a few steelhead.

17D-(3) Middle Fork of Toutle River: Enters just above the South Fork. It is several miles long, and should be surveyed.

17D-(4) Green River: (May 13-17, 1941; Frey and Bryant.) This large stream is tributary to the main Toutle River 26 miles above the mouth. Of a total length of 32 miles, 26.3 were surveyed to the impassable Black Falls. It is 90 feet wide at the mouth, and 35 feet wide at the falls. Its flow was 241 c.f.s. There were no dams, diversions nor pollution. The gradient averages 75 feet per mile, the current being fairly fast throughout. There are numerous beaches and benches along the lower 5 miles, but the uninhabited valley soon narrows to a rugged canyon over 1,000 feet deep in the mid section. It again widens slightly in the upper 14 miles. The lower half of the watershed has been logged off, but operations by the Wyerhauser Company are continuing above. The upper 15 miles are in a national forest, and its unspoiled watershed assures a good water supply. Seven miles above the mouth and just above Weyhauser's Camp #7, a large rock splits the stream into two channels, the main left channel having a 6 foot falls at the lower end and a 2 foot falls above. These falls are passable with some difficulty at low water periods and here the migrating fish can be observed and counted if desired. At 20 1/2 miles above the mouth is Big Falls, a total barrier with a 12 to 15 foot drop over a receeding rock ledge. At the end of the survey, 5 1/2 miles farther upstream is Black Falls, which has two impassable 60 foot cascades in a rocky gorge. The best spawning areas are in the lower 5 miles and in the 5 miles below Big Falls in the vicinity of the Soda Springs Forest Cabin. In the 855,000 square yards of total bottom below Big Falls there were 73,000 square yards of suitable spawning area available, or enough to accommodate several thousand salmon. Seventeen thousand square yards of suitable spawning area between Big Falls and Black Falls are unavailable until Big Falls is made passable. There were formerly extensive runs of chinook and silver salmon and steelhead in the river. At present fair runs of fall chinook and silver salmon are reported. These spawn mainly in the lower 6-7 miles of the stream, although some fingerlings were observed at least 2 miles above Camp 7. Steelhead spawn in the main river from the mouth of Devils Creek confluence (4.2 miles up) to Big Falls. Fifteen were counted, including 1 dead spent male, and several redds were seen by the survey party in the 5 mile stretch immediately below Big Falls. Rainbow and cutthroat trout were also taken in this section, and fingerlings were numerous. Like the South Fork of the Toutle River, this rather remote large stream seems ready for a rehabilitation program. Nearly all of the tributaries should be surveyed during the fall spawning period in order to get a true evaluation of the present runs.

17D-(4)a Devils Creek: (May 30, 1941: Frey.) Tributary to Green River 4.2 miles upstream. The total length is 7 miles, of which the lower 1/2 mile was surveyed. It was 15 feet wide, had a flow of 10 to 15 c.f.s and a gradient of 90 feet per mile. The water temperature was 49° F. The stream occupies a narrow, brush-choked uninhabited valley. A bed-rock chute 6 feet high located 360 yards above the mouth is a low-water barrier and difficult for the passage of fish at other times. Large rubble predominates, and the stream has little value for salmon at present, although a few silver salmon and steelhead are reported to enter and spawn in the poor rubble below the falls. The remainder of the stream should be surveyed.

Eleven small, steep, and inaccessible tributaries with a flow of 3 to 5 c.f.s. were observed between Devils Creek and Cascade Creek. A few silvers and steelheads probably spawn near the mouth of each.

17D-(4)b Cascade Creek: (May 17, 1941; Bryant.) Tributary to Green River 12.3 miles upstream, it is 5 miles long, but only the lower 500 yards were surveyed. It was 12 feet wide, had a flow of 10 to 15 c.f.s., and the gradient is approximately 250 feet per mile in the lower 2 miles. It is mainly a continuous series of cascades among small boulders and has little spawning rubble. No migratory fish were seen or reported.

17D-(4)c Elk Creek: (May 15, 1941; Frey.) Tributary to the Green River 14 miles upstream. The lower 500 yards were surveyed out of a total length of 6 miles. It was 15 feet wide, was flowing 15 c.f.s. and had a water temperature of 46° . It occupies a narrow canyon beginning a short distance above the mouth and has a fairly steep gradient. Four log jams and a 7 foot falls were passable with difficulty, and the U. S. Forest Service Ranger reported an impassable falls about 1 mile above the mouth. The bottom rubble is mainly large, and the scattered patches of suitable spawning rubble could accommodate very few salmon. A few 1 1/2 inch trout fingerling were seen. The stream should be inspected at fall spawning time.

17D-(4)d Shultz Creek: (May 15, 1941; Frey.) This stream joins the Green River 15.5 miles above the mouth. The lower 500 yards of a total length of 5 miles were surveyed. The stream forks at 1/2 mile upstream and is fed by 4 small mountain ponds. It was 20 feet wide, had a flow of 20 c.f.s., and a gradient of 350 feet per mile. The water temperature was 45° F. A difficult log jam at 200 yards should be opened. Although this stream has more good spawning rubble than most of the Green River tributaries, it can accommodate only a few fish. A single steelhead carcass was found 300 yards above the mouth.

17D-(4)e Trade Dollar Creek: (May 15, 1941; Bryant.) Joins Green River 18.3 miles upstream, and had a flow of 10 c.f.s. A few steelhead might spawn near the mouth, but it becomes too steep and rough a short distance above the mouth to be of much value to migratory fish.

17D-(4)f Miners Creek: (May 14, 1941; Frey.) Enters Green River approximately 19 miles above the mouth. The lower 1.4 miles were surveyed of a total length of 6 miles. It was 25 feet wide and had an estimated flow of 30 c.f.s. The gradient is about 250 feet per mile and the water temperature was 41° F. Several log jams, cascades and small falls were passable with considerable difficulty, but this remote forest stream is the largest and best of the Green River tributaries. In spite of its steep gradient, about 1/5 of the total bottom area is composed of suitable spawning rubble, with a total of more than 5,000 square yards occurring in the section surveyed. A small additional amount is believed present above the end of the survey before reported falls and cascades make further passage impossible. It is presumed that some of the salmon entering Green River ascend this stream. There were 11 steelhead observed, several of which were engaged in spawning activities. The stream could be improved by opening debris jams, enlarging the small pools below difficult cascades, and by restocking. It should be inspected in the fall of the year to determine the extent of its use by spawning salmon.

17D-(5) Alder Creek: (May 28, 1937; Hanavan and Whiteleather.) This stream joins the Toutle River 28 1/2 miles above the mouth and less than a mile below the St. Helens Bridge. 3 1/3 miles were surveyed of a total length of 6 miles. It was 20 feet wide, had a flow of 24 c.f.s. and a water level fluctuation of 3 to 4 feet. The gradient is moderate, about 70 to 90 feet per mile, and resting pools, although small in size, average 40 per mile. The water temperature was 47° F. and 48° F. There is no habitation along its course, and although fallen logs have formed a network over the channel, no real barriers were found. Some excellent spawning riffles are present, and suitable spawning areas exist for at least 500 pairs of salmon. There is little spawning rubble above the surveyed section, as the gradient becomes too steep and cascades are numerous. Silver salmon fingerling were abundant, indicating a good run of that species. A small run of steelhead is reported, but none were seen. The status of a reported run of chinook is not known. The stream could be improved by stocking, and should be checked occasionally for the formation of trash jams that may interfere with fish passage.

17D-(6) Hoffstadt Creek: (May 7 and 8, 1941; Frey and Bryant.) Enters the Toutle River 31 1/2 miles above the mouth. Seven miles were surveyed of a total length of 13 miles. The lower 6 miles are on the floor of a flat pocket in the Toutle Valley, and contain most of the spawning area. Here the stream was 35 feet wide, had a flow of 97 c.f.s. and the gradient is slight to moderate (26 to 75 feet per mile). Resting pools average 31 per mile, and are shallow, although

they are usually well protected by fallen logs and a dense jungle of marginal vegetation. There are no habitations along the stream. Many individually passable log jams and low cascades might collectively hinder upstream migration, but the first real obstruction is an 8 foot falls cascading through boulders 6.8 miles above the mouth, this was considered to be a low-water barrier. A series of falls in a log and snag filled rocky gorge at the end of the survey was considered a total barrier. Since the survey was made, the timber has been cut along this stream, and therefore it should be re-inspected for possible new log and debris jams. About 1/3 of the total bottom area, or 37,000 square yards, consisted of suitable rubble, and the stream should accommodate at least 1,000 pairs of salmon. Seven adult steelhead and several redds were seen, and others may well have been present and unobserved, for visibility was poor. No data are available on salmon runs, but there is no apparent reason why chinooks and silvers should not use the stream. It is recommended that the obstructions be opened to facilitate fish passage. The remainder of the stream should be surveyed to see if there is sufficient spawning above to warrant a fishway at the falls.

17D-(6)a Bear Creek: (May 7, 1941; Frey and Bryant.) Enters Hoffstadt Creek about 1 1/2 miles above the mouth. Approximately 3.8 miles were surveyed of a total length of 9 miles. This stream is very similar to Hoffstadt Creek, but it has a slightly lower gradient. It is 20 feet wide, and had a flow of 25 c.f.s. There were over 30 log and trash jams that were possible barriers, and in some sections the water could not even be seen from the banks. The lower half mile is a continuous riffle with no large rubble. There was a total of 9,000 square yards of suitable spawning area, which was about 1/5 of the entire bottom. Most of this area is apparently little used at present. Only 1 adult steelhead was seen, together with 3 redds, although a few more steelhead may have been present. The stream could be greatly improved by removing trash barriers and restocking. Four small tributaries flowing less than 5 c.f.s. were observed, but these have little additional spawning area.

17D-(6)b Cow Creek: (May 7, 1941; Frey and Bryant.) This tributary joins Hoffstadt Creek four miles above the mouth. It was 6 feet wide and had a flow of but 3 to 5 c.f.s. The water temperature was 58° F. There is a little spawning area near the mouth.

17D-(7) Deer Creek: This stream joins the Toutle River 33 miles above the mouth where it enters in several channels through a small flood plain. Only 5 miles long, it is reported to have some spawning area in its lower two miles, but a 25 foot falls is said to block the stream at that point. Steelhead and silver salmon are reported to use it.

17D-(8) Jackson Creek: (June 1, 1941; Frey.) Tributary to the Toutle River 38 miles above the mouth. It is 4 1/2 miles long, one mile having been surveyed. It is 12 feet wide and had a flow of 8 c.f.s. The gradient is 120 feet per mile in the lower 2 1/2 miles, and the water temperature was 45° . The lower 2 miles of the main stream and 1 1/2 miles of a tributary meander through the Toutle River flood plain. Resting pools are small and shallow but average 48 per mile, and are separated by some excellent spawning riffles. Suitable spawning area totaled 3400 square yards or 37 per cent of the total bottom. There is little spawning in the steeper section above the flood plain. Old residents report former large runs of silver salmon and steelhead.

17D-(9) Elk Creek: (June 1, 1941; Bryant.) This 3-mile stream joins the Toutle 41 1/2 miles above the mouth. The lower 3/4 mile was surveyed. The stream had a flow of 5-6 c.f.s. and the gradient was moderate, with very small resting pools averaging 15 per mile. It was too shallow for salmon to go more than 800 yards above the mouth and is said to be nearly dry in the late summer. It had only 400 square yards of suitable spawning area and there are no salmon reported. Trout fingerling were the only fish seen.

17D-(10) Mirada Creek: (June 1, 1941; Frey.) Tributary to the Toutle River 44 miles upstream. Mirada Creek is 3 miles long; only the lower 3/4 mile was surveyed. This small stream had a flow of 7 to 10 c.f.s. and does not get as low as Elk Creek in the summer. Windfalls have left many logs across the channel and 1 difficult jam should be removed. There were 1100 square yards of suitable spawning rubble, which was 22 percent of the total bottom. A small run of silver salmon is reported in the fall, and a few steelhead enter in the spring. Few fingerlings were observed.

17D-(11) Castle Creek: (May 9, 1941; Bryant.) Tributary to the Toutle 44 1/2 miles upstream, it is 5 miles long and 4.7 miles of 5 miles were surveyed. This stream is 30 feet wide and had a flow of about 50 c.f.s. The gradient is 170 feet per mile in the lower 2 miles and 400 feet per mile above. Resting pools average 13 per mile in the lower 2 miles, and only 2 per mile in the steeper section above. There are no habitations along the stream. At 150 yards above the mouth there is a log and debris jam which is a partial barrier to migratory fish. In several places in the lower 3 miles there are tangles of fallen trees across the stream and 8 such jams were difficult for the passage of fish. Three miles above the mouth the stream plunges abruptly over a 30-foot ledge, and this falls is a total barrier. Four hundred yards farther up a series of small falls and a bedrock chute is a low-water barrier. There were 7100 square

yards of suitable spawning area available in the 50,000 square yards of total bottom area below the falls, and 1100 square yards more above the falls that are unavailable at all times. Some additional spawning area is present near the mouths of 4 small tributaries entering below the falls. Ten adult steelhead and 8 redds were counted in the lower two miles and probably more adults were present. Trout fingerlings were abundant below the falls but were absent above. The stream should be checked during the fall spawning season to determine its possible use by fall-run salmon. This clear stream should support a run of several hundred fish, but only a small part of the available spawning area is now being used.

17D-(12) Coldwater Creek: (Inspected Sept. 4, 1940; Parkhurst and Bryant. Surveyed May 2 and 9, 1941; Frey.)
This stream enters the Toutle River 45 miles above the mouth and approximately 6 miles below Spirit Lake outlet. It is 8 miles long, the lower 1 1/2 miles was surveyed. It is 15 to 20 feet wide, had a flow of 25 to 30 c.f.s., and the gradient in the lower 4 miles averages 120 feet per mile. Resting pools average 24 per mile, and are small and shallow. The water is clear and cold, the temperature being 41° on May 2, 1941. In the lower 1/2 mile below the mouth of the South Fork the stream flows under dense brush and overhanging limbs. Numerous small log and brush jams are difficult for fish to pass. Above the South Fork the stream flows quietly through a large marshy area and over a sandy bottom. There is a fall reported to be 6 feet high located 2 miles above the mouth. In a total bottom area of 30,000 square yards there are 2,200 square yards of suitable spawning area below the marsh and possibly a small additional amount in the steeper section above it. On September 4, 1940, carcasses of 26 large, spawned-out chinook were found in the lower half-mile of the stream. It is believed that these were either a spring run of fish that had summered in the main Toutle, or were an early summer run of fish that had gone directly onto the spawning grounds. The deterioration of the carcasses found indicated that these fish had completed their spawning and died prior to mid August, and fall run chinook would not be expected before September. Steelhead spawn in Coldwater Creek in the spring. Thirteen adults were counted below the swamp area in May and a few others may have gone farther upstream. The remainder of this stream should be surveyed, preferably at spawning time.

17D-(12)a South Fork of Coldwater Creek: (May 2, 1941; Bryant.)
This branch joins Coldwater Creek 1/2 mile above the mouth, and is 5 miles long, the lower mile to a beaver swamp having been surveyed. It is 15 feet wide, had a flow of 10 to 15 c.f.s., and is very similar to main Coldwater Creek. Thirteen hundred yards above its mouth there is a 6-foot falls which is a barrier to salmon. There were beaver dams at the lower end of the swamp that were believed to be passable with difficulty. There is a maze of small channels through the swamp, and the steep gradient

above it of 300 feet per mile makes the upper portion of the stream of little value. In a total bottom area of 7600 square yards, there were 1100 square yards of suitable spawning area below the falls, the bottom in the swampy area above being composed mainly of sand. Three adult steelhead and 3 redds were observed below the falls and a fair number of trout fingerlings were present. No fish were seen above the falls. A few chinook salmon probably also work their way up from Coldwater Creek as far as the falls. The available spawning area is not well utilized at present.

17D-(13) Studebaker Creek: (June 1, 1941; Bryant.) This tributary enters the Toutle River 48 miles upstream. It is 3 miles long but only 3/4 mile was surveyed. The stream is 9 feet wide and had a flow of 10 to 15 c.f.s. In the first 100 yards a series of log and trash jams lodged in boulders and filled in above with sand and gravel create a series of small falls totaling 25 feet in height that is at least a low-water barrier and may block fish at all times. The stream forks at 300 yards, the lower fork being too small for salmon spawning. At 560 yards upstream, ascending the main branch, a 3-foot log and boulder dam is a low-water barrier and difficult for fish to surmount at any time. These barriers should be removed if the stream is ever improved and stocked. The gradient averages 380 feet per mile in the lower 2 miles, and there are no resting pools. The riffles are very shallow and there were only 560 square yards of suitable spawning area. A few silver salmon have been reported, but the stream is of little present value to migratory fish.

17D-(14) Spirit Lake: (September 15 and 16, 1936; Suomela and Jobes.) Spirit Lake is located at the head of the Toutle River and at the northeastern foot of Mt. St. Helens. The lake is about 5 miles in length, up to 1 1/2 miles wide, and has an irregular 13-mile long shoreline with two main arms. It may be considered an alpine lake, as its elevation is 3,199 feet. The shoreline is heavily wooded with small conifers, and there are a considerable number of submerged, or partially submerged trees along the shoreline. There are occasional narrow shoals, consisting mainly of pumice, along the shores; but the outer slope of these few shoals drops as sharply as the loosely-piled pumice will allow to depths as great as 190 feet, as ascertained by a series of soundings. Bottom samples taken with an Eckman dredge were composed almost entirely of black coze, and preliminary examination indicated only small amounts of food organisms at the greater depths. The condition of suckers and other fish observed would indicate, however, that organisms are probably more abundant on the shallower bottom sections.

Surface plankton tows at four stations indicated that the zoo plankton occurred in abundance and was rather evenly distributed over the entire lake. Surface water temperatures were 15.1° C to 15.3° C. (59.1° F. to 59.5° F.) and bottom temperatures at depths of 103 to 190 feet were 4.5° C to 4.8° C. (39.6° F. to 40.6° F.).

The fish population consists of suckers, squawfish, rainbow trout, cutthroat trout, and landlocked blueback salmon. In 1943, 1944, and some previous years silver salmon have been observed spawning in lower Bear Creek, a small tributary, and on some bars along the lake margins; but in other years many have been unable to pass the small dam at the outlet during the low-water period in the fall. Rainbow and cutthroat trout up to 5 pounds are taken, with an occasional specimen of 9 to 12 pounds being on record. All tributaries are small, with flows of less than 5 c.f.s., and are blocked within 350 yards of the lake by impassable falls, shallow areas, or cascades.

Bear Creek: About 20 feet wide, is blocked by a bedrock slope at 250 yards upstream, where it had an estimated flow of only 2-3 c.f.s. The water temperature was 44° F.

Margaret Creek: Blocked 355 yards upstream by a 25-foot falls. The creek was 6 to 20 feet wide, had a small flow, and the water temperature was 41° F.

Harmony Falls Creek: Accessible for approximately 60 yards to an impassable high falls. The stream was approximately 10 feet wide.

Cedar Creek: A very small stream having good but limited spawning gravels occurring only at its mouth and along the lakeshore near it for a short distance.

Donneybrook Creek: Similar to Cedar Creek, except for the lack of good tributaries for spawning.

Spirit Lake appears well suited to blueback salmon and future utilization of this area for fish propagation purposes is being considered by the Fish and Wildlife Service. A small planting of experimentally-marked fish of this species were released in the lake in the fall of 1943 for checking purposes, but only a few were recovered as adults.

17E. Olequa Creek: (May 26, 1937; Hanavan and Lobell.) This stream enters the Cowlitz River 22 miles above the mouth. It is 20 miles long, of which the lower 15 miles were surveyed to the formerly impassable England Lumber Company dam at Winlock, Washington. It is 60 to 70 feet wide, and had a flow of more than 20 c.f.s. at a point 3 1/4 miles above the mouth. In most places it occupies a gorge 6 to 60 feet deep. The hilly watershed has been logged, and the valley floor is covered with farms. There are two towns along the stream course, Winlock, and Vader, Washington. The gradient is low to moderate, and there are many deep, large pools, and a dense marginal vegetation. A low falls 5.2 miles upstream and a log and brush jam 12 1/2 miles upstream are difficult for fish to pass at some water stages. The 25 foot dam at Winlock had blocked all fish for nearly fifty years until 1947 when the State Fish and Game Departments with the cooperation of the owners constructed a new fishway.

At the time of the survey occasional sawmill pollution and washings from a gravel crusher below Winlock and from another below Ryderwood on Campbell Creek were both clouding the waters of Olequa Creek and had overlaid much of the stream bed with heavy deposits of silt and sediment. In addition raw sewage was being poured into the river from the towns of Winlock, and Vader, and indirectly from Ryderwood; this, together with refuse and drainage from farms and garbage dumps caused the stream pools to be dank, foul smelling, and oily, and the stream banks to be covered with sludge, algae and molds. The State Pollution Control Commission has forced correction of some of the garbage pollution problems, and satisfactory sewage disposal plants are now being considered by the towns. With the pollution problem corrected, and the dam made passable, the stream should again become important to the production of salmon and steelhead. There is spawning area below the dam for at least 2,000 pairs of salmon, with the best areas located above the lower 5 miles. There are 7 to 9 miles of stream now available to salmon above the dam. A small run of steelhead has persisted in this stream, but there are apparently no significant runs of chinnoks, silvers, or chum salmon remaining. Only an occasional fish has been reported by residents of the area in recent years, and no fingerlings were seen by the survey party above the confluence with Stillwater Creek. The stream should be re-stocked with steelhead trout and silver salmon as soon as possible.

17E-(1) Stillwater Creek: (May 28, 1937; Hanavan and Lobell.) This 13-mile tributary joins the Olequa about 3 miles above the mouth. Washings from a gravel crusher on Campbell Creek, a tributary entering 6 miles above the mouth, prevented observations on the lower section and made it unfit for fish. The next 5.3 miles were surveyed, and here the stream was 13 feet wide, had a moderate gradient and resting pools averaged 39 per mile. The water temperature was 54° F. The watershed has been logged and there has not been sufficient regrowth to check the resulting erosion; consequently there was considerable silting of the spawning beds. If silting is checked through reforestation, there will be sufficient spawning area for at least several hundred pairs of salmon, with the best riffle areas occurring in the first 3 miles above Campbell Creek. A small run of silver salmon and steelhead was reported and fingerlings of both species were seen. The remainder of the stream and its lower tributary, Brim Creek, should be surveyed.

17E-(1)b Campbell Creek: (May 25, 1937; Baltzo and Jobes.) This stream enters Stillwater Creek 6 miles above its mouth and is 8 miles long. The lower 2.6 miles was surveyed to an impassable dam. It is 10 feet wide, had a flow of 9 c.f.s., and a gradient of 50 to 75 feet per mile. Resting pools average 17 per mile, and the water temperature was 49° F. A log jam 2/3 mile above the mouth is difficult for the passage of fish and should be removed.

Sewage from the town of Ryderwood and silt from a county gravel crusher made the lower 1 1/3 miles unfit for fish. The dam is 6 feet high and diverts much of the flow for the water supply of the town of Ryderwood. The portion of the stream above the dam will continue to be unavailable to salmon and steelhead unless a fish ladder is provided. There is spawning area for a few fish in the first mile of clear water below the dam and a few silver salmon were seen in this stretch. The concentration of pollution in the lower 1 1/3 miles was believed to keep many fish from entering the creek, and its elimination would improve not only this stream but the lower 6 miles of Stillwater Creek and the lower Olequa as well. The remainder of this stream should be surveyed.

17E-(1) b-i Decker Creek: (May 27, 1937; Baltzo and Jobes.) This small stream enters Campbell Creek about 3/4 mile above the mouth, is 4 miles long, and had a flow of 4 c.f.s. Although its small size limits its production, it was found to have some very good spawning riffles. A few silver salmon and steelhead are reported to use it, and fingerlings were numerous.

17E-(2) Unnamed Creek:

17E-(3) Ferrier Creek: These are the only tributaries of any size entering Olequa Creek between Stillwater Creek and the town of Winlock. They are 4-6 miles in length, have a normal flow of 3 to 12 c.f.s., and do not support large runs of salmon. Ferrier Creek has long been blocked by a swimming pool dam south of Winlock, but a ladder will be constructed over this dam to open formerly productive spawning areas above it. Good silver salmon and steelhead runs formerly entered the streams.

17F. La Camas Creek: (May 24-26, 1937; Baltzo and Jobes.) This stream is 22 miles long and enters the Cowlitz River 27 miles above the mouth. Sixteen miles have been surveyed. It is 70 feet wide, has a gradient of only 30 to 50 feet per mile, and the flow was 6 c.f.s. A water temperature of 67° was recorded 6 miles above the mouth, and the stream may be found to be too warm for good salmon production. In the lower 6 miles the stream flows through a narrow valley between logged-off hills, and with the exception of a silted area in the lower 1/2 mile, the best spawning areas are located in this section. The valley opens above, and in the upper 5 miles surveyed the stream is generally sluggish with silting occurring on much of the bottom. At a point 13.8 miles above the mouth a 6-foot dam diverts water for the operation of a farm lighting plant. A similar dam is located 500 yards farther upstream. Both of these obstructions are barriers to fish at low water. A brush jam below the first dam should be removed. There have been good runs of silver salmon into this stream, but the 1936 run was reported to have been unusually late and small, probably because of the exceptionally low water occurring throughout the area that year. Fingerlings were abundant in the lower 10 1/2 miles, but were absent in the silted section above. There is suitable spawning rubble for at least 1,000 pairs of salmon, excluding the silted areas, and the spawning capacity could be more than doubled by stream improvements.

17F-(1) Ayell or Bear Creek: (May 23, 1937; Baltzo and Jobes.) This small tributary enters about 1/2 mile above the mouth of La Camas Creek. It had a flow of 3 c.f.s. and its watershed has been logged. Its gradient is moderate and there are some good spawning riffles in the lower portion. A 6 foot dam was removed by the Washington State Fish and Game Departments in 1947. Residents report a few salmon (probably silvers) in the fall, but the stream is too small to support a large run.

17G Salmon Creek: (May 22 and 24, 1937; Baltzo and Jobes.) This stream is 35 miles long, of which the lower 15.2 miles have been surveyed; the remainder should also be surveyed. It is 60 to 75 feet wide and had a flow of 13.8 c.f.s. at a point 4 1/2 miles above the mouth. The gradient is only 25 to 35 feet per mile in the lower 11 miles, increasing to 50 to 90 feet per mile in the next 4 miles. Logging operations has exposed much of the stream, and it is probable that the water temperature in the summer would be so high that salmon would not remain in the lower third of the stream. Erosion of the exposed earth and clay banks causes the water to be turbid and has covered much of the bottom with silt deposits. The logging operations have also directly interferred with the salmon runs, for a former large run of silver salmon is said to have been nearly exterminated during the years prior to 1932, when shingle bolts and logs were driven down the stream channel. The runs are reported to have been increasing slowly since that time and are apparently utilizing the upper and faster portion of the stream. A few steelhead also are reported to spawn in the headwaters, and there may be a few chinook salmon. When reforestation was eliminated some of the silting and lowered the water temperature, restocking may be feasible. In the total bottom area of 367,000 square yards there is sufficient good spawning area for at least 3,000 pairs of salmon. All log and debris jams should be removed. Most of the tributaries noted by the survey party were too small to be of value.

17G-(1) Little Salmon Creek: Tributary to Salmon Creek 3 miles upstream. This stream had a flow of 4 c.f.s. and a small amount of spawning rubble near the mouth.

17G-(2) Cedar Creek: Enters Salmon Creek 11 miles above the mouth. It is several miles long, and had a flow of 5 c.f.s. Spawning area is limited at present because of silting, and a 25-foot impassable falls is reported 2 miles above the mouth.

17H Mill Creek (or Hurd Creek): (April 30, 1941; Frey and Bryant.) This stream is 13 miles long and enters the

Cowlitz River 56 miles above the mouth. It occupies a deep narrow canyon in its lower few miles, and a 20 foot falls is reported to block all salmon runs about 1 mile above the mouth. Silver salmon are said to spawn below the falls, and therefore it should be checked at spawning time, and any debris jams should be removed.

17I. Winston Creek: (April 30, 1941; Frey and Bryant.) This 15-mile long tributary joins the Cowlitz 59 miles upstream, but is blocked by an impassable 40-foot falls located only 250 yards above its mouth. There is little spawning area below the falls. The flow was small, estimated at 10 c.f.s. Since the stream is quite long it should be surveyed during the fall spawning period to see whether there is sufficient spawning area above the falls to warrant the cost of constructing a fishway.

17J. Klickitat Creek: (April 30, 1941; Frey) Tributary to the Cowlitz River 62 miles above the mouth, it is 3 1/2 miles long and 800 yards were surveyed. The gradient is steep, and a series of impassable bedrock chutes and falls 6 to 14 feet in height block the stream near the end of the survey. It is valueless for salmon and no runs have ever been reported.

17K. Tilton River: (October 16 to 20, 1936; Baltzo and Jobes.) Tributary to the Cowlitz River 63 1/2 miles above the mouth. The Tilton is 26 miles long; the lower 22.6 miles to an impassable 18 foot falls was surveyed. The drainage area is 158 square miles. The stream is over 50 feet wide and a flow of 76 c.f.s was measured at a point 8 miles above the mouth, the stream being unusually low at the time. U.S.G.S. records taken at a point 2 1/2 miles upstream list a maximum flow of 9,850 c.f.s. on November 23, 1942, and a minimum of 66 c.f.s. on September 11 and 12, 1944. Resting pools average 9 per mile and the water temperature was between 50 and 54° . The valley is narrow in the lower 6 miles, with a deep canyon occurring 3 to 6 miles upstream. Above the canyon the valley is quite wide and dotted with farms. Domestic sewage from the towns of Morton and Lindberg was the only pollution noted. Three very difficult log jams, the upper one being over 1/2 mile long, were observed between 12 and 16 miles above the mouth. A power dam 10 feet high is located 15 1/2 miles above the mouth and 1 mile below the town of Morton; it was formerly a partial barrier to anadromous fish. Through efforts of the Washington State Department of Fisheries the dam was blasted out in September, 1944, thus opening the upper portion of the river to future spawning runs. There is sufficient spawning area in the 823,000 square yards of total bottom in the river to accommodate at least 9,000 pairs of salmon, and with the exception of a two mile stretch between Cinnabar and Bear Creeks, there are many excellent riffles and spawning areas all along the river above the lower canyon. A good run of silver salmon still uses the stream, and 407 were counted on the spawning beds by the 1936 survey party. A smaller run of fall chinooks exists;

212 spawners were counted, mostly below Morton and undetermined numbers of both chinooks and silvers were seen in large pools. On October 30, 1945, 10 live and 2 dead chinook and 106 live and 4 dead silver salmon were counted in a 2 mile stretch near the mouth of the West Fork. A fair run of winter steelhead and sea-run cutthroat is reported, and the former is being increasingly sought after by sportsmen. The available spawning area in this stream and its tributaries is not fully utilized at present and the system has a high potential value.

17K-(1) Cinnabar Creek: (Oct. 19, 1936; Baltzo and Jobes.) This stream is 5 miles long and enters 3 miles above the mouth of the Tilton River; but it is entirely inaccessible because of a 75 foot falls at its mouth.

17K-(2) Bear Canyon Creek: Enters the Tilton River 6 miles above the mouth. It is 3 miles long, and is inaccessible due to cascades and a steep gradient.

17K-(3) Alder Creek: Enters the Tilton River 7 miles above the mouth. It is 2 1/2 miles long, had a flow of 1 c.f.s., and is blocked by an impassable windfall at its mouth.

17K-(4) North Fork of the Tilton River: (July 20-21, 1937; Hanavan, Baltzo, and Lobell.) This tributary enters the Tilton River 12 1/2 miles upstream. It is formed by the union of Winnie and Jesse Creeks, and its total length of 6.6 miles was surveyed. It is 36 feet wide at the mouth, had a flow of 48 c.f.s., and the water temperature was 55° F. to 57° F. It flows between high forested ridges, the gradient being moderately steep and the current quite fast. Several cascades and low falls are passable with some difficulty, and in the lower 2 1/2 miles a waterfall 6 feet high and another 9 feet high could be made more easily passable. Several log jams are partial barriers, and should be removed. There were 137,000 square yards of bottom. Enough is suitable for spawning to accommodate at least 1100 pairs of fish, although it occurs for the most part in scattered patches. Silver salmon and steelhead are reported to work their way to the headwaters. The presence of numerous fingerlings, including 2 year classes of silvers, indicated that the spawning was quite successful.

17K-(4)a Jefferson Creek: (July 20, 1937; Baltzo.) Enters 1/2 mile above the mouth of the North Fork. Its flow was only 1 c.f.s., and it is of no value to salmon.

17K-(4)b Bromo Creek: (July 20, 1937; Baltzo.) Tributary to the North Fork 2 miles upstream. It was almost dry and is of no value to salmon.

17K-(4)c Fisher Creek: (July 20,1937; Baltzo.) Joins the North Fork just above Bromo Creek. It is small and accessible for only a short distance. It has very little value for salmon its flow being about 4.6 c.f.s.

17K-(4)d Wallanding Creek: (July 20, 1937; Baltzo.) It enters three miles above the mouth of the North Fork, is 5 miles long, 19 feet wide and had a flow of 15 c.f.s. It was surveyed for 3/4 mile to an impassable 12 foot falls. The current is quite fast, but there is spawning area available for a few fish. The best spawning rubble is above the impassable falls, which also blocks access to Tumble Creek. Tumble Creek had a flow of 5 c.f.s. and a small amount of spawning rubble near the mouth.

17K-(4)e Otter Creek: (July 20, 1937; Jobes.) Tributary to the North Fork four miles above the mouth. It is a small stream with a flow of 5 c.f.s. Spawning areas are poor above the lower 100 yards due to the steep gradient and predominatly large rubble. A few silver salmon fingerlings were observed near the mouth.

17K-(4)f Rockies Creek: (July 21, 1937; Baltzo.) This tributary enters the North Fork five miles upstream. It had a flow of 3 c.f.s., and is blocked by a ten foot falls over and through a log jam located 100 yards above the mouth.

17K-(4)g Jesse Creek: (July 21, 1937; Baltzo.) Joins Winnie Creek to form the North Fork, is 3 miles long, and had a flow of 5 c.f.s. An impassable 20 foot falls blocks the channel 300 yards above the mouth.

17K-(4)h Winnie Creek: (July 21, 1937; Lobell.) Similar to Jesse Creek which it joins. About 1200 yards were surveyed to an impassable falls 18 feet high. A log jam 700 yards upstream also may be a total barrier. A few silver salmon and trout fingerling were observed near the mouth, but the total spawning area is small.

17K-(5) Highland Creek: (October 16, 1936; Baltzo.) This stream joins the Tilton River 16 miles upstream, below Morton, Washington. Its flow was 1 c.f.s. and it has no value for salmon.

17K-(6) Davis Creek: (October 16, 1936; Baltzo.) This small stream joins the Tilton River 17 miles upstream and drains out of Davis Lake, which is shallow and rush-bordered. The stream flow was 8 c.f.s., and the water was turbid. Were it not for the sediment, it would have some small spawning value.

17K-(7) Connelly Creek: (October 31, 1936; Baltzo.) Joins the Tilton River 18 1/2 miles upstream, and is 6 miles long. It flow was only about 1 c.f.s., but is higher during the spring, when a few winter or spring steelhead enter the stream. Silver salmon also have been reported.

17K-(8) Mines Creek: (Oct. 21, 1936; Hanavan.) This very small tributary enters the Tilton River 19 1/2 miles upstream. It was nearly dry when surveyed to an impassable falls and dam located 1/2 mile above the mouth, and has very little value.

17K-(9) East Fork of the Tilton River: (July 16 and 17, 1937; Hanavan) Enters the Tilton River 20 1/2 miles upstream and 5 1/2 miles were surveyed of a total length of 9 miles. It is 30 feet wide and had a flow of over 25 c.f.s. The water temperature was 66° F. The gradient is quite steep and several cascades in canyon-like sections are very difficult for the passage of fish. The stream is well protected by thick marginal vegetation and box canyon walls. Lumbering operations on the upper watershed were beginning to fill the stream with log jams and debris that should be removed. In spite of the gradient, the stream has some excellent though small patches of spawning rubble with a sufficient capacity for at least 900 pairs of salmon. The silver salmon run was said to have utilized the entire stream during the low-water period in 1936. Silver salmon and trout fingerling were observed. An impassable falls was reported 1 1/2 miles above the end of the survey and 1/2 mile below a fork in the stream.

17K-(9)a South Fork of the East Fork of the Tilton River: (July 16, 1936; Lobell.) The South Fork joins the East Fork at 1.8 miles above the mouth of the latter. It is 4 1/2 miles long and approximately 2.9 miles were surveyed. It was 10 feet wide, and had a flow of 9 c.f.s. The gradient is moderate and small resting pools are numerous. Several log jams and beaver dams are passable with some difficulty. The survey was terminated in a beaver swamp, but silver salmon are reported to go even farther up the stream. Silver salmon fingerlings were numerous, indicating that the stream is fairly well utilized by that species. Spawning area was present for at least 250 pairs of salmon.

17K-(10) Nineteen Creek: (Inspected Oct. 21, 1936; Whiteleather.) Enters 21 1/4 miles above the mouth of the Tilton River, is 4 miles long and had a flow of 1 c.f.s. It is reported to be much larger in the spring. The stream is blocked 3/4 mile above the mouth by an impassable 12 foot falls and log jam. There is suitable spawning area available below the falls for less than 100 fish.

17K-(11) West Fork of the Tilton River: (July 17 to 20, 1937; Hanavan and Lobell.) Five miles of a total length of 8 miles was surveyed to an impassable log jam on the left branch, and to an 8 foot falls in a series of cascades on the right branch, both obstructions being impassable. There are two channels at the mouth, with a combined width of 40 feet. The gradient is steep, but small resting pools are numerous. The water temperature was 66° F. at the mouth and 56° F. at the end of the survey. There is some silting in the lower two miles, and logging operations were being conducted on the upper watershed. Several bad log jams were found. Suitable spawning area is available for at least 700 pairs of salmon if it is not spoiled by further logging operations, and was utilized by a good run of silver salmon. Numerous fingerling of this species were observed below the impassable log jams. A few steelhead enter the stream and cutthroat trout were observed.

17K-(11)a Coon Creek: (July 19, 1937; Lobell.) This 3 mile long tributary joins the West Fork of the Tilton River 2 miles upstream and 1 1/2 miles was surveyed to the confluence with Snow Creek. Its flow was approximately 13 c.f.s. at the mouth, and 5 c.f.s. just above Snow Creek. The stream runs through a canyon for the most part. The considerable number of silver salmon fingerlings observed indicate that its small spawning areas are well used.

17K-(11)a-i Snow Creek: (July 19, 1937; Lobell.) This small tributary joins Coon Creek 1 1/2 miles upstream and is blocked by a 15 foot falls located 250 yards above its mouth. A few silver salmon fingerling were observed below this barrier.

17K-(11)b Eagle Creek: (July 19, 1937; Hanavan.) This creek enters the West Fork 4 1/2 miles above the mouth, and is 3 miles long. It is blocked 1 mile above the mouth by an impassable series of falls. Silver salmon fingerlings were observed below the falls where there is a small amount of spawning area. A small upper tributary, Trout Creek and its tributary, Soos Creek, are inaccessible because of the falls.

17L. Sulphur Creek: (April 30, 1941; Frey and Bryant.) This stream 6 1/2 miles long enters the Cowlitz River 71 miles above the mouth. The survey included the lower 1.7 miles on the Cowlitz valley floor and was terminated at an impassable 12 foot, bedrock chute. This chute is surmounted by a 6 foot dam that is used to divert water to a planer mill. The stream was 12-15 feet wide and had a flow of 5 c.f.s. The gradient is moderate; small resting pools average 26 per mile, and are protected by thick marginal vegetation.

The water temperature was 53° F. Several brush jams and beaver dams are passable with difficulty. Due to the presence of a large amount of mud and sand, particularly near the mouth, there is suitable spawning area for only about a hundred fish. The area above the section surveyed is quite steep, and improvement would be too costly for the small additional spawning area that could be opened. No salmon were seen, but a resident stated that chinook ascend to the falls. Silver salmon fingerlings were observed near the mouth. Trout fingerling were seen, but no steelhead were reported.

17M Shelton Creek: (July 15, 1937; Hanavan.) Tributary to the Cowlitz River 78 miles upstream, it is 3 1/2 miles long. The lower 1/2 mile to an impassable, 13 foot falls was surveyed. It was 15 feet wide and had a flow of about 7 c.f.s. The stream is in a canyon and is almost a continuous series of cascades and low falls. There is spawning area for only a few fish. Small silver salmon fingerling were quite abundant below a 9 foot cascade 800 yards upstream, and a few trout fry were observed.

17N Landers Creek: (July 15, 1937; Lobell.) Enters the Cowlitz River 81 miles upstream and is 9 miles long. Approximately 2.9 miles were surveyed to an impassable series of falls and log jams with a combined height of about 100 feet. The lower 2 miles is on the Cowlitz River flood plain where the gradient is slight and the stream is 12 to 60 feet wide. There are some excellent spawning riffles in this section with suitable spawning area available for at least 300 pairs of salmon. Above this section the stream is in a steep canyon, has many cascades and log jams, and is of little value to salmon. Silver salmon fingerling were abundant in the lower 2 miles, indicating a good run of that species.

17N-(1) Wakeawasis Creek: This small tributary enters Landers Creek 1 1/2 miles upstream, but was not surveyed. It may have a small amount of spawning rubble near the mouth, but soon becomes too steep to be of much value.

17-O Sand Creek: Tributary to the Cowlitz River 82 miles upstream it is 6 miles long and was not surveyed.

17P Staffen Creek: (June 11, 1936; Kolloen and Shuman.) Formed by the confluence of Uden and Frost Creeks, Staffen Creek enters the Cowlitz River 85 miles above the mouth of the latter. It is 2.6 miles long and was all surveyed. It is 15 feet wide and meanders on the Cowlitz valley floor where, in the lower mile, it is usually contained in a dirt-walled ravine 20 to 30 feet deep. The gradient is slight and the water temperature was 55° F. There is suitable spawning rubble available for at least 500 pairs of fish, and more could be accommodated if the current were not so sluggish in many sections. Numerous salmonoid fingerlings were observed, most of which were silver salmon.

17P-(1) Uden Creek: (June 12, 1936; Kolloen and Shuman.) This stream is 4 miles long; the lower 1 1/2 miles was surveyed. It is 10 feet wide and had a flow of 8.5 c.f.s. Good resting pools are scarce, averaging not over 1 per mile, and water temperature was 52° to 54° F. The lower 300 yards is swampy, but the next 1/2 mile flows through pastered land and has spawning area for about two hundred salmon. The steeper area above has little spawning area, the rubble being too large. Silver salmon fingerling were unusually numerous in the lower 3/4 mile, but none were observed above.

17P-(2) Frost Creek: (June 11, 1936; Kolloen and Shuman.) This stream is 4 miles long, 3.3 miles having been surveyed. Its gradient is slight; good resting pools average only 2 per mile, and the lower 1 1/2 miles are swampy. Part of the channel is the middle section has been ditched and the stream is bordered by pastureland. The upper half-mile surveyed had an increased gradient with some excellent small spawning riffles that could support a few salmon. The survey ended at the beginning of a steep canyon where tumbling cascades preclude the possibility of much spawning area above. A few unidentified salmonoid fingerling were observed in the upper half-mile, but no reliable information could be obtained on migratory fish in the stream.

17Q Rainey Creek: (June 10 to 12, 1936; Kolloen and Shuman.) This stream is 10 miles long and enters the Cowlitz just above the mouth of Staffen Creek. At times anastomosing flood channels may connect the two streams near the mouth. Nine miles were surveyed. The stream is 35 feet wide and had a flow of 73 c.f.s. Most of its course is in a fairly flat valley 1/2 to 1 mile wide, and the gradient is moderate. Resting pools average 9 per mile and the water temperature was 50° to 52° F. A log jam 2.4 miles above the mouth was considered to be a barrier and should be removed. Two other difficult log jams were present in the lower 5 miles and another was found 8 miles above the mouth. Obstructions should be removed in this stream, for there is suitable spawning area present for at least 1300 pairs of salmon in the 108,000 square yards of total bottom. Unidentified salmon fingerlings were observed and a good run of salmon, probably silvers, is reported to enter in the fall. Steelhead are reported to spawn mainly in the tributaries, and resident trout are scarce.

17Q-(1) Lunch Creek: (June 11, 1936; Shuman.) This stream enters Rainy Creek 5 miles above the mouth and extends for 2 1/2 miles. The lower mile was surveyed to an impassable 15 foot falls near the mouth of a canyon. It is 7 feet wide and had a flow of 7.3 c.f.s. Except for the upper 300 yards surveyed, it flowed rather sluggishly through farmlands in a flat valley.

Spawning area was available for a few salmon and numerous fingerlings were observed. A fall run of salmon, believed to be silvers, and a small run of spring steelhead is reported. Resident trout are scarce. A small tributary, the East Fork of Lunch Creek enters about 1 mile upstream, and small salmonoid fingerlings were seen in its lower 200 yards which lie below an impassable falls.

17Q-(2) North Fork of Rainey Creek: (June 10, 1936; Shuman.) This stream joins Rainey Creek 8 miles upstream and is only 2 miles long. The lower 5/8 mile was surveyed to an impassable falls. It is 10 to 12 feet wide and had a flow of 12 c.f.s. There are few good pools and the water temperature was 49° F. Spawning is confined to the lower 300 yards, as all of the stream above is in a steep canyon. A few steelhead are reported to use the stream.

17R. Peterson Creek: A tributary 3 miles long, enters the Cowlitz River 87 miles upstream. It is intermittent, but could accommodate a few silver salmon near its mouth.

17S Goat Creek: (July 31, 1937; Baltzo.) This stream enters the Cowlitz River 89 miles above the mouth. It is 5 miles long, but is blocked 500 yards above the mouth by an impassable 35 foot falls. It is 18 feet wide, and had a flow of 15 c.f.s. When the Cowlitz river is low the water in Goat Creek is said to diffuse through gravel bars at its mouth. A few silver salmon fingerlings were observed below the falls, but the stream has very little value for salmon.

17T Tumwater Creek: (July 31, 1937; Baltzo.) This short stream enters the Cowlitz River 91 miles upstream. It has a steep gradient, discharges about 1 c.f.s., and is of no value to salmon.

17U Cispus River: (April 23 to 28, 1941; Frey and Bryant.) This stream enters the Cowlitz River 92 1/2 miles above the mouth, and is one of the largest tributaries, being about 50 miles long. The lower 33 1/2 miles were surveyed to the impassable 30 foot Gail Falls. The lower 6 miles are bordered by benches and hills recently denuded by logging operations. Proceeding upstream through a canyon-like section, the stream valley widens slightly so that there is a narrow valley floor between 8 and 18 miles above the mouth. The upper 13 miles surveyed are also in a canyon. Most of this upper section of the watershed had been swept by a bad forest fire a few years previously. U.S.G.S. records show that the high-water period extends from December through May with a mean flow at a point 15 miles above the mouth, of between 1,100 and 1,900 c.f.s. During the low-water period between August and November the mean flow is usually 300 to 400 c.f.s. The gradient increases from 20 feet per mile near the mouth to 150 feet per mile near the falls. Resting pools average 8 per mile and are usually large, deep, and fairly well protected. The water temperature varied between 42° F. and 48° F. Glacial silt is brought into the stream from Mt. Adams during the summer months, but

the current is usually sufficient to prevent silting on the spawning riffles. Other than a Forest Camp and one or two farms, there are no habitations on the stream, but the upper portion is fairly accessible from a road up the valley from Randle, Washington. There are no obstructions downstream from a bedrock chute and boulder cascades in the 1/2 mile immediately below the falls.

There are 287,000 square yards of suitable spawning rubble in the main stream, or 16 per cent of the total bottom. The best spawning grounds are between 11 and 15 miles above the mouth, but only a very small part of the suitable spawning area is used at present. A small run of spring chinook salmon and a larger run of fall chinook salmon is reported. Chinook have been observed spawning near the C.C.C. Camp bridge 15 miles upstream, but good observation is often impossible due to the glacial silt carried by the water. A fair run of silver salmon enters in the fall, and a good part of the run is reported to spawn in the accessible tributaries. A small run of steelhead trout spawn in the river in the spring. Four live adults and 1 dead steelhead were seen. Three fish were on redds and 3 additional untended redds were observed, and other fish were undoubtedly present in the turbid water. Brook trout, resident rainbows, and whitefish also were caught by the survey party. The stream appears to be considerably understocked at present. The remainder of the stream should be surveyed to determine whether construction of a fish ladder at Gail Falls is advisable.

17U-(1) Copper Canyon Creek: (July 31, 1937; Baltzo.) This tributary enters 1 mile above the mouth of the Cispus River. It has a flow of 1 to 5 c.f.s. and is shallow and difficult to enter at low water periods. A few salmon fingerling were observed near the mouth, but it has little value as a spawning stream.

17U-(2) Quartz Creek: (Oct. 22, 1936; Whiteleather and Hanavan.) Enters the Cispus River 3.7 miles upstream and is 9 miles long. About 3 1/2 miles were surveyed. It is 12 to 15 feet wide, had a flow of 9 1/2 c.f.s., and the water temperature was 44° F. and 45° F. The gradient is steep, averaging 176 feet per mile; the resting pools are small, averaging only 4 per mile, and cascades and small falls are numerous. There are also many windfalls and 2 bad log jams; one is located 1100 yards above the mouth, and the other about 3 miles upstream. A 6 foot falls and rapids 1 2/3 miles upstream is perhaps a barrier in some seasons, and another 10 feet high 2 3/4 miles above the mouth is believed to be a total barrier. A few steelheads are reported to spawn below these upper falls, but since about 70 percent of the bottom is composed of large rubble, there is suitable spawning area for only a few fish.

17U-(3) and (4) Crystal Creek, 4 1/2 miles upstream and Woods Creek, 5 miles upstream are too small and steep for salmon to enter.

17U.(5) Iron Creek: (August 2, 1937; Hanavan and Lobell.) Enters the Cispus 8 miles upstream is 11 miles long. About 2.7 miles was surveyed to an impassable 30 foot falls. It is 28 feet wide and had a flow of 36 c.f.s. The water temperature was 52° F. and the PH 7.6. The gradient is steep, averaging 161 feet per mile, and although large resting pools are lacking, the small cascade pools averaging 78 per mile can be used by salmon. Several cascades and falls 3-6 feet high are difficult and could be improved. There is considerable fluctuation in water level, and a severe flood in 1934 is reported to have raised the stream 20 feet in the canyon sections and severely damaged the stream bed. At present there is suitable spawning area in scattered small patches below the falls for 300 or 400 pairs of salmon. A small run of silver salmon enters the creek, spawning mainly in the lower 1 1/2 miles where numerous fingerlings were observed. Trout fingerling were seen, but no data could be obtained as to the occurrence of steelhead.

17U-(6) and (7) Nash Creek and Falls Creek: (April 23, 1941; Bryant.) These streams enter 10.1 and 10.8 miles upstream respectively. Both are small and inaccessible for any distance because of cascades and falls, and are of no value to salmon.

17U-(8) Greenhorn Creek: (October 23, 1936; Hanavan and Whiteleather.) This stream is 7 miles long, of which the lower 2 miles were surveyed to an impassable 60 foot falls. It is 9 feet wide and had a flow of 7 to 10 c.f.s. when inspected on April 23, 1941. The water temperature was 43° F. to 45 1/2° F. The gradient is steep, averaging 260 feet per mile, and there is an average of only one resting pool per mile, although small cascade pools are numerous. The stream is "rough", most of it being in a canyon and cluttered with logs and debris. About 75 percent of the bottom is large rubble; suitable spawning area is confined to small patches and capable of supporting only a few fish. Entrance is difficult during low water periods, but a few steelheads are reported to use the stream.

17U-(9) and (10) Stump Creek and Dry Creek: (Inspected April 23, 1941; Frey and Bryant.) Enter Cispus 13 1/2 and 15 miles upstream. Both are small steep streams with stream beds composed chiefly of large rubble, and are of no value to salmon.

17U-(11) Niggerhead Creek: (October 22 and 23, 1936; Baltzo and Jobes.) One of the larger Cispus tributaries, this stream enters 16 miles upstream. It is 13 miles long, of which 5 1/4 miles were surveyed to an impassable 25 foot falls. It is 20 feet wide, and had a flow of 26 c.f.s. at a point one mile above the mouth. The gradient is 47 feet per mile in the lower 1.6 miles, where the best spawning areas are located, and increases to 126 feet per mile in the next 3 1/2 miles. Small resting pools average 27 per mile and the water temperature was 40° F. to 44° F. A 5 foot falls 3 miles upstream is an obstacle to the passage of fish, and a huge log jam 25 feet high, located 3.3 miles upstream is a total barrier, Two other falls near the end of the survey are difficult for fish and are possibly low water barriers. There is suitable available spawning area for about 700 pairs of salmon and more is present above the impassable log jam. A small run of spring chinook salmon enters the stream, two carcasses having been found. A fair run of silvers enters in the fall, and 85 were counted, 50 of them being in a pool at the foot of the impassable log jam. Fall chinook and steelhead have been reported and Eastern Brook trout were present.

17U-(11)a High Bridge Creek: Enters Niggerhead Creek 3 miles upstream; had a flow of 1 c.f.s., and is impassable.

17U-(11)b and c Lambert Creek: Enters Niggerhead Creek 3.5 miles upstream and Galena Creek enters 3.8 miles upstream. Both were flowing about 1 c.f.s., and are steep and of no value to salmon.

17U-(11)d McCoy Creek: Enters Niggerhead Creek 5 miles upstream, is 9 miles long, but was found to have many cascades and is blocked 0.4 miles above the mouth by a 50 foot falls. It has little value for salmon.

17U-(12) Camp Creek: Enters the Cispus 16.2 miles upstream. It is a small steep stream, and has no value for salmon.

17U-(13) North Fork of the Cispus River: (August 1 and 2, 1937; Kolloen and Baltzo.) This tributary joins the Cispus River 18 miles upstream. It is 15 miles long, of which the lower 6 miles were surveyed to an impassable series of bedrock falls totaling 25 feet in height. The stream is 18 feet wide, had a flow of 72 c.f.s. and is the largest and best of the Cispus tributaries. Resting pools average 44 per mile and the water temperature was 49° F. to 51° F. The lower 1/2 mile is on the open Cispus valley floor and the lower part of the stream is quite heavily fished by sport fishermen. The next 1 1/2 miles is in a box canyon,

but the stream valley widens slightly before another canyon is encountered 4 miles upstream. The gradient is moderate, 50 to 125 feet per mile, and the well-forested watershed allows a more gradual runoff than in most of the more exposed Cispus tributaries. There are some excellent spawning riffles, and in a total bottom area of 112,000 square yards there is suitable spawning area for at least 1400 pairs of salmon, but it is not being fully utilized. Silver salmon fingerlings, including 2 year classes, were abundant to the falls, indicating a fairly good run of that species. A run of chinook salmon (probably fall-run) is present, and on October 30 and November 1, 1945, there were counted 129 live and 1 dead chinook, and 33 live and 2 dead silver salmon in a 3 mile section of the river near the road bridge. Large numbers of salmon fry were collected in fyke nets in late January and February 1946. Steelhead redds were observed in the lower 2 miles by the 1937 survey party, and rainbow and cutthroat trout were present in fair numbers in the 3 miles immediately below the falls. The stream should be surveyed above the falls to determine whether a fish ladder is desirable.

All tributaries observed, including Tyler, Polk, Irish, Swede, Midget, Jackpot, Siwash, and Yazoo creeks, had a flow of only 1 to 2 c.f.s. and were too small and steep to be of value, although a few salmon might spawn at their mouths. Timonium Creek, entering 7 1/2 miles upstream and just below the impassable falls is larger, but has an impassable series of falls 75 feet high at its mouth.

17U-(14) to (17) Horse Creek: at 19.7 miles, Smoothrock Creek at 21.2 miles, and Blue Lake Creek at 22 miles upstream, are Cispus River tributaries with flows of less than 3 c.f.s., and are too steep to be of value. Juniper Creek, 24 miles upstream has a small amount of spawning near its mouth, but is impassable immediately above.

17U-(18) East Canyon Creek: (Oct. 25, 1936; Whiteleather.) This stream 10 miles long enters the Cispus River 28 1/2 miles upstream, but is blocked by an impassable 40 foot falls 300 yards above the mouth. Spawning area exists for a very few salmon below the falls. Four adult silver salmon were observed.

17U-(19) Squaw Creek: (April 26, 1941; Frey.) Entering the Cispus River 30 1/2 miles upstream, this stream is 2 1/2 miles long, 10 feet wide, and had a flow of 5 to 7 c.f.s. Its gradient is so steep that it has little value.

17U-(20) Adams Creek: (April 25, 1941; Frey and Bryant.) Entering the Cispus 31.7 miles upstream, this tributary is 11 miles long and 12 to 20 feet wide. It has a flow of 8 to 15 c.f.s., which is maintained through the summer by melting snows on Mt. Adams.

This stream carries large quantities of silt later in the summer, which discolors the Cispus River below the confluence. The water temperature was 44° F. The lower 1/2 mile is in a rocky gorge, 10 to 15 feet wide in which there are several falls up to 6 feet in height, and little spawning area. A 15 foot falls topped by drift logs 400 yards above the mouth is a barrier to fish, and not even resident rainbows were observed above it. There is some good spawning rubble present above the falls, but the stream is believed to be unfit for fish. Its tributary, Sheep Creek had a flow of 5 to 8 c.f.s., but also was entirely devoid of fish life.

17U-(21) Orr Creek: (April 25, 1941; Frey and Bryant.) This small stream is 8 feet wide and had a flow of 5 to 10 c.f.s. It has some spawning rubble and is believed to be of some slight value to anadromous fish.

Several small, steep tributaries enter the Cispus above Gail Falls, but these were not surveyed in detail. In upstream order they are: Cat, Muddy Fork, Pimlico, Midway, Wesley, Elk, Chambers, Walupt Lake and Goat Creeks. Falls are reported to block Cat Creek and the stream running out of Walupt Lake.

17V Schooley Creek: (June 13, 1936; Hanavan.) This small tributary enters the Cowlitz River 99 miles above its mouth. It had a flow of less than 1 c.f.s. and is of little value to salmon although a few silvers spawn near its mouth.

17W Siler Creek: (June 13, 1936; Kolloen and Shuman.) Enters the Cowlitz River 100 miles above the mouth. It is 7 miles long and 2.6 miles were surveyed to two impassable falls 12 and 22 feet in height. It is 27 feet wide, but flows through a swampy section in the first mile above the mouth where it has little current, no good pools or riffles, and a mud and sand bottom. The gradient increases slightly for the next 1 1/2 miles and here there are a few pools and spawning area sufficient for at least 200 pairs of salmon. The remainder of the stream is abruptly steeper and has little value. No data could be obtained on the extent of its use by migratory fish, but a few unidentified salmonoid fingerlings, probably silvers, were seen in the upper mile surveyed. Its only tributary, Squire Creek, enters 2 miles upstream and was inspected for 1/2 mile, but was found to be too small to be of importance. Its flow was about 1 c.f.s.

17X Kiona Creek: (July 31, 1937; Hanavan and Lobell.) Enters the Cowlitz 101 miles upstream. It is 10 miles long, of which 5 1/4 miles were inspected to a forks. The stream is 15 feet wide and has a flow of 5 to 8 c.f.s. The water temperature was 51° F. to 61° F. and on October 2, 1945 a water temperature reading of 50° F.

and a flow of 9 c.f.s. was recorded at the Randle-Cispus road bridge. The lower 4 1/2 miles are in a swamp, the channel being choked with debris. The bottom in this section is mostly sand, and there is only a little spawning area. The next mile of stream to the forks has a slightly increased gradient and many excellent riffles with spawning area for at least 200 pairs of salmon. Silver salmon fingerlings were so abundant in this section that the stream resembled a hatchery rearing pond, and it is evident that the spawning area is quite well utilized. There is doubtless a little additional spawning in the two branches above, but they are both small, neither having a flow of more than 3 c.f.s. Several small debris jams should be removed from the stream. Two tributaries, Peters Creek and Oliver Creek, have small flows and a little additional spawning area. Silver salmon fingerlings were numerous near the mouth of each.

17Y Mill or Miller Creek: (June 8, 1936; Kolloen and Shuman.) Enters the Cowlitz River at Randle, Washington, 108 miles above the mouth. It is 2 1/2 miles long, of which 1/2 mile was surveyed to an impassable 30 foot falls. The stream is 14 feet wide and had a flow of 28 c.f.s. It has a moderate gradient, and flows through pasture lands from a gorge near the falls. Spawning area is present for a few salmon, and silvers are reported to utilize it. The stream was polluted with sewage and garbage from the town of Randle at the time of observation.

17Z Silver Creek: (August 4, 1937; Hanavan, Lobell, Baltzo and Kolloen.) Enters the Cowlitz River 105 miles above the mouth. This stream is 12 miles long, of which the lower 2.7 miles, to an impassable 20-foot falls were surveyed. It is 19 feet wide and had a flow of 30 c.f.s. On October 2, 1945 a flow of 73 c.f.s. and a water temperature of 51° F. was recorded 3/4 mile above the mouth. The lower 2 miles is on the Cowlitz flood plain where the gradient is slight, and resting pools average 18 per mile. This stretch contains the best spawning rubble, there being sufficient in the entire 2.7 miles surveyed for at least 700 pairs of salmon. The remainder of the stream is in a steep canyon and has a gradient of 140 feet per mile. Only occasional small patches of spawning rubble occur between numerous cascades and low falls, some of which are 4 to 8 feet high and very difficult for the passage of fish. A low dam 1.8 miles above the mouth diverts about 10 c.f.s. to a small power plant, the return is 230 yards below. There is normally no spill over the dam except for leakage through the dam, and adequate passage for fish should be provided. The diversion is protected from drift by slats spaced 2 1/2 inches apart, but these do not effectively bar the passage of down-stream migrants. Silver salmon fingerlings were numerous in the lower two miles, indicating good utilization of the stream by that species. A small steelhead run also exists. One dead adult steelhead was seen, but steelhead fingerlings were scarce. One tributary, the East Fork of Silver

Creek, enters below the impassable falls, but is so steep that it has very little value. It is blocked by an impassable log jam 50 feet high 1/4 mile upstream. A few salmon are reported below the log jam.

17AA Purcell Slough and Hopkins Creek: (Inspected Aug. 1, 1937; Hanavan and Lobell.) This is located 109 miles above the Cowlitz River mouth and consists of 3 or 4 channels that at times connect Hopkins Creek and Davis Creek with the Cowlitz. Since various water stages in the Cowlitz can alter the channels, they should be re-investigated when improvements are contemplated. Hopkins Creek above the slough had a flow of about 3 c.f.s. and was reported to support a small run of silver salmon.

17BB Davis Creek: (July 31, 1936; Hanavan and Lobell.) Tributary to the Cowlitz 111 miles above the mouth. This stream is 6 miles long, of which two miles were surveyed to an impassable 20 foot falls. It is 15 feet wide, and had a flow of 4 c.f.s. Resting pools average 13 per mile and the water temperature was 51° F. The lower mile is on the Cowlitz flood plain and there are often several shifting channels, (see Purcell Slough above). The stream bed is composed mostly of mud or sand, and seepage causes some channels to go nearly dry in the summer. The next mile between the flood plain and the falls has a steeper gradient and suitable spawning area for a few salmon. There are 2 small log jams and small falls in the upper 1/4 mile surveyed that should be removed. Silver salmon fingerling are numerous, and a few steelhead fingerlings also were observed.

17CC to EE. Cunningham Creek: At 110 1/2 miles, Owens Creek at 111 miles, and Cougar Creek at 112 miles above the mouth of the Cowlitz River are all intermittent streams of little or no value to salmon. When investigated on June 5, 1936, they all had flows of 2 to 3 c.f.s.

17FF Kilborn Creek: (June 5, 1936; Kolloen.) Tributary to the Cowlitz River 112.2 miles above the mouth. It is 5 miles long, of which the lower 3/4 mile was surveyed to an impassable 35 foot falls. The stream was 18 feet wide and had a flow of 15 c.f.s. Resting pools average 10 per mile and the water temperature was 47° F. A log jam 6 feet high, is located 50 yards above the mouth. There is spawning area for a few fish in the lower 1/2 mile, but the gradient is very steep above that point. Silver salmon and steelhead are reported to ascend to the falls. Cutthroat trout were observed, and Montana black spotted trout have been planted above the falls.

17GG Garret Creek: (June 5, 1936; Kolloen and Shuman.) Enters the Cowlitz River 114 miles above the mouth. It is 2 1/2 miles long and is blocked by an impassable 12 foot falls 1/2 mile above the mouth. It lacks good pools but has some good spawning

riffles. It had a flow of 10 c.f.s., but is reported to be intermittent. A few silver salmon are said to use the stream, but no fish were seen.

17HH Burton Creek: (June 4, 1936; Kolloen.) Enters the Cowlitz River 115 miles above the mouth. The stream is 3 1/2 miles long, of which the lower 1.3 miles were surveyed to a series of impassable cascades in a box canyon. It is 40 feet wide and the flow was 22 c.f.s. Shallow pools are frequent and the water temperature was 57° F to 59° F. The lower 1/2 mile is swampy and lacks spawning rubble. There is spawning area for a few salmon in the next 2/3 mile, but the remainder of the stream up to the falls has an exceptionally steep gradient and the bottom is composed of large rubble. Although silver and chinook salmon, steelhead, and cutthroat trout have been reported, the stream has little value.

17HH-(1) East Fork of Burton Creek: (June 4, 1936; Kolloen.) This tributary enters the swampy section of lower Burton Creek. It is 3 miles long, of which the lower mile was surveyed. The lower portion is swampy and has many windfalls across it which should be removed. There are some small shallow pools and good riffles with suitable spawning area for a few salmon. In some years the stream is said to be intermittent, but the observed minimum flow was 2 c.f.s. Silver salmon and trout are reported, and silver fingerlings were numerous. A large run of silvers for the size of the stream was reported in 1935.

17II Willame Creek: (July 25, 1937; Hanavan.) Enters the Cowlitz River 118 miles above the mouth. It is 8 1/2 miles long of which the lower 825 yards were surveyed to an impassable 30 foot falls. It was 21 feet wide and had a flow of 15 to 18 c.f.s. The water temperature was 63° F. The stream occupies a rough canyon in a heavily wooded, mountanious country. Cascades and low falls increase upstream in number and height, and are often difficult for the passage of anadromous fish. Large rubble predominates, and suitable spawning areas for a few salmon are found only along the lower edges of the pools. Silver salmon fingerlings were numerous and the available spawning area is well utilized. The stream is believed to be too steep and rough above the falls to be much value to migratory fish.

17JJ Dry Creek: Tributary to the Cowlitz River 119 miles above the mouth. It is intermittent and of no value.

17KK Smith Creek: (June 3, 1936; Baltzo.) This 10-mile long stream enters the Cowlitz River 119.3 miles above the mouth. One mile was surveyed to a 20 foot impassable falls. The stream is 24 feet wide, but all except the lower 1/4 mile is in a steep canyon. There is suitable spawning area for only a very few salmon. The stream was considered too steep and rough above the falls for any additional value to anadromous fish.

17LL Johnson Creek: (July 27 and 28, 1936; Kolloen and Baltzo.) Enters the Cowlitz River 120 miles above the mouth. This stream is 12 miles long, of which the lower 5 miles to the mouth of Glacier Creek were surveyed. It is 37 feet wide and had a flow of 132 c.f.s. Small resting pools average over 36 per mile and the water temperature was 48° F. to 53° F. On October 2, 1945 a water temperature of 49° F. and a flow of 65 c.f.s. was recorded at the highway bridge. The lower 1 1/2 miles below an impassable log jam are on the Cowlitz flood plain where the gradient is moderate, and suitable spawning is available for at least 400 pairs of salmon. The remainder of the section surveyed is in a steep, rough, deep canyon. In this section there are many cascades and several low falls 3 to 5 feet high. A second log jam, 30 feet high and 300 feet long, occurs 2 miles above the mouth, and is probably impassable to fish, as is the 15 foot Jennings Falls, surmounted by a log jam 10 feet high, and located 4.3 miles upstream. There was potential spawning area for an additional 500 pairs of salmon above the lower impassable jam. A fair run of silver salmon is reported, and fingerlings were observed below the lower log jam. Steelhead trout are also reported. All tributaries large enough to support salmon enter above the falls and are therefore inaccessible.

17MM Hall Creek: (June 6, 1936; Kolloen and Shuman.) This stream 3 1/2 miles in length enters the Cowlitz River 120 1/2 miles above the mouth. The lower 1.6 miles were surveyed. It flows almost entirely on the Cowlitz flood plain through extensive swamp areas. It is 34 feet wide, the gradient is slight, and the pools are large. Algae and waterplants grow on much of the bottom and there is suitable spawning area for very few salmon. Several beaver dams may be barriers to migratory fish. Small runs of silver salmon and steelhead are reported. Hager Creek, a tributary entering from a steep mountainside, is believed to be unimportant.

17NN Skate Creek: (July 25-29, 1937; Baltzo and Kolloen.) This fair sized tributary enters the Cowlitz River 123 miles above the mouth near Packwood, Washington. The stream has a total length of 14 miles, of which 8 3/4 miles were surveyed. It is 23 feet wide and had a flow of 36 c.f.s. Resting pools average 30 per mile, and the water temperature was 50° F. to 61° F. The lower mile on the Cowlitz flood plain has a slight gradient and spawning area for at least several hundred salmon (see Figure 7). The mid section of the stream is in a canyon 4 miles long where there are some scattered patches of spawning rubble. The upper 3 miles of the creek are in a wider valley and have spawning area for a few hundred more salmon. Occasional debris jams were difficult for the passage of fish. At 2 1/3 miles above the mouth a hillside was slipping into the stream channel and had already formed several rubble dams 6 to 7 feet high that are believed to be impassable at low water. The stream can support at least 1400 pairs of salmon and its potential carrying capacity would be higher if the stream were not

subject to severe scouring by freshets in the narrow canyons. Silver salmon and steelhead trout runs are reported. Steelhead fingerlings were fairly abundant throughout, but silver fingerlings were most abundant in the lower 2 miles. Boulder, Dixon and Rock creeks are small tributaries flowing less than 1 c.f.s., and are of no importance. Johnson Creek, entering 7 miles upstream is larger (20 c.f.s.), but is blocked by a series of 6 to 10 foot falls 400 yards above the mouth.

17-00 Butter Creek: (July 26, 1937; Lobell.) Enters the Cowlitz River 125 1/2 miles above the mouth. The stream is 10 miles long, and was surveyed for 1 1/4 miles to a very difficult 20 foot bedrock chute. An impassable 30 foot falls is located 1/4 mile farther upstream. The stream was 31 feet wide and had a flow of 80 c.f.s. Resting pools average 22 per mile and the water temperature was 58° F. In the lower 1/2 mile on the Cowlitz flood plain there are often several channels with some fine riffles that would provide spawning area for at least 300 pairs of salmon. The remainder of the section surveyed is in a steep box canyon with a gradient of 165 feet per mile, and has little value. Numerous silver salmon fingerlings indicate that it is well utilized by that species. Trout fingerlings were also seen.

17PP Lake Creek: (July 24, 1937; Baltzo.) Originating at Packwood Lake this 5-mile long stream enters the Cowlitz River 126 miles above the mouth. The lower 1.9 miles were surveyed to an impassable 25 foot falls. The stream is 41 feet wide, had a flow of approximately 150 c.f.s., and the water temperature was 63 1/2° F. The water was turbid with silt. The gradient is so steep, averaging 250 feet per mile, and the stream bed contains so much large rubble that there is little suitable spawning area. There are some debris jams and many rapids and cascades. There is excellent spawning area in the lower 300 yards, but only occasional small patches above. The spawning area would accommodate at least 250 pairs of salmon. Silver salmon fingerlings were numerous and 30 steelhead redds were counted in the lower section, indicating that the available spawning area is well utilized.

17QQ Muddy Fork of the Cowlitz River: (June 26, 1936; Hanavan, Kolloen, and Baltzo.) Entering the Cowlitz River 127.4 miles above the mouth, the Muddy Fork extends for 11 miles to its source at Cowlitz and Paradise Glaciers on Mt. Rainier. The stream is 50 to 60 feet wide, and is high and turbid with glacial silt during the summer months. The lower mile is on the Cowlitz flood plain, and is almost a continuous riffle with spawning area for at least 300 pairs of salmon. The remainder of the stream is in a steep canyon. Indians formerly caught many salmon at the mouth, and it was reported that a few spring chinook salmon still ascend for some distance. Silver salmon, fall chinook and steelhead have been reported.

FIGURE 7. Excellent spawning area in Skate Creek, tributary to the upper Cowlitz River

17RR Coal Creek: (June 3, 1936; Shuman.) Enters the Cowlitz River 127.6 miles above the mouth. The stream is 6 miles long, but is blocked 2/3 mile upstream by an impassable 75 foot falls. It is 24 feet wide, and cold, the water temperature being 43° F. There is a spawning area for about 100 pairs of salmon near the mouth, but a steep gradient of over 435 feet per mile in a canyon above makes the stream of little value. No migratory fish were seen or reported.

17SS Purcell Creek: (June 3, 1936; Kolloen.) Entering the Cowlitz River 129 1/2 miles above the mouth, this stream 2 1/2 miles long was surveyed for a distance of 1/3 mile to an impassable 60 foot falls. A few silvers are reported to utilize the few excellent riffles near the mouth.

17TT Clear Fork of the Cowlitz River: (July 24 and 29, 1937; Hanawan and Baltzo.) This stream joins the Ohanapecosh River to form the main Cowlitz River. It is 16 miles long, of which the lower 1 1/2 miles were surveyed to a series of 6 falls and cascades above which salmon have never been reported. It is 30 to 50 feet wide and had a flow of 150 to 190 c.f.s. High water occurs in June with a flow of over 1200 c.f.s., and during the low water period in November the flow is often down to 30 c.f.s. (U.S.G.S. records) There is spawning area for only a few salmon near the mouth below a rough, steep canyon. The State of Washington installs racks in the stream near the mouth in order to secure chinook salmon for artificial propagation. Small runs of steelhead and silvers enter the stream to spawn in the lower mile. Dam Creek, with a flow of 5 c.f.s., and Cartright Creek, with a flow of 15 to 20 c.f.s., are both blocked at their mouths by 30 to 50 foot falls and have no value. All other tributaries are above the cascade barrier and are inaccessible at present.

17UU Ohanapecosh River: (July 24, 1937; Lobell.) This stream originates at a glacier of the same name on Mt. Rainier. It is 15 1/2 miles long, of which the lower 1.1 miles were surveyed. It is 60 feet wide and quite deep, with a steep canyon located but a short distance above the mouth. A log hatchery dam 12 feet high is located 700 yards above the mouth forms the upper limit of salmon migration. The 1/2 mile stretch between the dam and the confluence with Summit Creek has 8 falls from 5 to 23 feet in height, and above which no salmon runs have ever been reported. There is spawning area for a few hundred fish near the mouth. The State Department of Fisheries installs hatchery racks 180 yards upstream where spring and fall chinook and steelhead eggs are taken for artificial propagation. There is therefore little natural spawning in the stream at present. Silver salmon are also reported. All tributaries are steep and blocked by falls or the hatchery dam.

TABLE OF OBSTRUCTIONS AND DIVERSIONS [1]

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Main Cowlitz River	Cowlitz Falls	6-8	None	Fishway or widen channel
Coweman River	3 falls	5, 6, 9	None	Fishways
	2 splash dams	38	None	Survey above
Mulholland River	Splash dam	30	None	Survey above
	Falls	11	None	Survey above
Ostrander Creek	4 Cascades	4-7	None	Fishway
	10 log jams; 22 beaver dams	3-10	None	Remove
South Fk. Ostrander Cr.	Water supply dam and sawmill dam	2	None	Fishway. Screen the diversion
	Falls	8	None	Fishway
	Log jam and beaver dams	3-7	None	Remove

(1) This tabulation includes only those obstructions and diversions which would seriously interfere with runs of salmon and steelhead in the stream.

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
North Fk. Arkansas Cr.	Log and debris jams	5-6	None	Remove
South Fk. Arkansas Cr.	6 log and debris jams	5-6	None	Remove
Monahan Creek	Series of 3 falls	18	None	Survey above
Toutle River	2 dams and log jam	2-3	None	Fishways
Outlet Creek	Log jam	?	None	Remove
Johnson Creek	Logging debris	6	None	Remove
Eighteen Creek	Falls	Impassable	None	None
Twenty Creek	Falls	6	None	Survey above falls
Whitten Creek	Falls	30	None	None
Bear Creek	Falls	10	None	None
Green River	Camp #7 Falls	6, 2	None	Study at migration time
	Big Falls	13	None	Fishway
	Black Falls	60	None	None

TABLE OF OBSTRUCTIONS AND DIVERSION

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Devils Creek	Bed-rock chute	6	None	Survey above
Elk Creek	4 log jams; 2 falls	6	None	Survey to reported impassable falls. Remove log jams.
Shultz Creek	Log jam	7	None	Survey
Miners Creek	Log jams and cascades	5	None	Remove lower barriers and survey above
Alder Creek	Trash jams	4-5	None	Remove
Hoffstadt Creek	Falls and Cascades	8, 5	None	Survey above
	Log and trash jams	3-6	None	Remove
Bear Creek (17D-(6)a)	Log and trash jams	3-6	None	Remove
Deer Creek	Falls	25	None	Survey above
Mirada Creek	Log and debris jams	3-6	None	Remove
Castle Creek	9 log jams	4-10	None	Remove
	Falls and Chutes	30, 7	None	None

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction and Diversion	Height in feet	Existing Protective Devices	Recommendations
Coldwater Creek	Falls	6	None	Survey above
	Log and trash jams	3-5	None	Remove
South Fk. Coldwater Cr.	Falls	6	None	Survey above
Studebaker Creek	Log and boulder falls and cascades	25, 3	None	Recheck at spawning time, and remove if necessary
All Spirit Lake tributaries	Falls	8 to 40	None	None
Oliqua Creek	Falls	4	None	Fishway
	Log and brush jam	4	None	Remove
	England Sawmill Dam	25	Fishway	None
Campbell Creek	Ryderwood water supply dam	6	None	Survey above
LaCamas Creek	2 farm power dams	6, 4	None	Fishways
	Log jam	8	None	Remove

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction and Diversion	Height in feet	Existing Protective Devices	Recommendations
Cedar Creek (17g-2)	Falls	25	None	Survey above
Mill Creek (17H)	Falls	20	None	None
Winston Creek	Falls	40	None	Survey above
Klickitat Creek	Bedrock chutes, falls and log jams	10, 6, 14, 8	None	None
Tilton River	Falls	18	None	None
	Beaver dams and 3 log jams	3-10	None	Remove
Cinnabar Creek	Falls	75	None	None
Alder Creek (17K-3)	Debris jam	6	None	Remove
North Fk. Tilton River	Cascades, falls and log jams	6, 9, 5, etc.	None	Remove log jams. Fishways.
Wallanding Creek	Falls	12	None	Survey above
Rockies Creek	Log jam falls	10	None	None
Jesse Creek	Falls	20	None	None

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstructions or Diversions	Height in feet	Existing Protective Devices	Recommendations
Winnie Creek	Falls	18	None	None
Mines Creek	Falls and dam	Impassable	None	None
East Fk. Tilton River	Cascades, Log jams	3-7; falls impassable	None	Survey above; remove log jams
Nineteen Creek	Falls and log jam	12	None	Survey above
West Fk. Tilton River	Falls; log jams	8; 4-10	None	
Snow Creek	Falls	15	None	None
Eagle Creek	Apron falls	Impassable	None	None
Sulphur Creek	Falls with dam	12-6	None	None
	Beaver dams and jams	3-6	None	Remove
Shelton Creek	Cascades and falls	9, 13	None	
Landers Creek	Series of falls and log jams	100 (combined)	None	Remove log jams
Rainy Creek	4 log jams	4-10	None	Remove

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstructions or Diversions	Height in feet	Existing Protective Devices	Recommendations
Lunch Creek	Falls	15	None	None
North Fk. Rainy Cr.	Falls	Impassable	None	None
Goat Creek	Falls	35	None	None
Cispus River	Gail or Cat Creek falls	30	None	Survey above
Quartz Creek	2 falls	6, 10	None	Survey above
	Cascades and log jams	6, 12	None	Improve lower 2 miles
Iron Creek	Cascades and falls	3 to 6; 30	None	None
Greenhorn Creek	Cascades and log jams	3-8	None	Remove log jams
	Falls	60	None	None
Niggerhead Creek	Log jam	25	None	Remove
	4 falls	5, 6, 20, 25	None	Survey above

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
McCoy Creek	Falls	50	None	None
North Fk. Cispus River	Series of falls	25	None	Survey above
Timonium Creek	Falls	75	None	None
Blue Lake Creek	Falls	5	None	None
East Canyon Creek	Falls	40	None	None
Adams Creek	Falls and log jam	4 to 15	None	None
Siler Creek	2 falls	12, 22	None	None
Kiona Creek	Brush and log jams	4-7	None	Remove
Mill Creek (17Y)	Falls	30	None	None
Silver Creek	26 cascades; 4 falls	3, 8, 8, 4, 20	None	Fishways
	Farm power dam	1	2 1/2" grizzly on diversion	Fishway; install small mesh screen on diversion

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
East Fk. Silver Creek	Log jam	50	None	None
Davis Creek	Cascades; 2 log jams; falls	4, 5, 20	None	Remove log jams
Kilborn Creek	Log jam; Falls	6, 35	None	Remove log jams
Garret Creek	Falls	12	None	None
Burton Creek	Series of cascades	Impassable	None	None
East Fk. Burton Creek	Log and brush jams	3-6	None	Remove
Willame Creek	Cascade falls; falls	4-5; 30	None	Survey above
Smith Creek	Falls	20	None	Survey above
Johnson Creek (17LL)	Cascades and 2 log jams	2-5; 8, 30	None	Remove log jams
	Falls, topped by log jam	15, 10	None	Survey above
Hall Creek	Beaver dams	3-5	None	Remove

TABLE OF OBSTRUCTIONS AND DIVERSIONS

Name of Stream	Name or Type of Obstruction or Diversion	Height in feet	Existing Protective Devices	Recommendations
Skate Creek	Debris jams and low falls and cascades	4-7	None	Remove log jams
Johnson Creek (17NN-5)	Series of falls	6-10	None	Survey stream
Butter Creek	Bed-rock chute, falls	20-30	None	None
Lake Creek	Apron falls	25	None	None
Coal Creek	Falls	75	None	None
Purcell Creek	Falls	60	None	None
Clear Fork Cowlitz River	Series of low falls and cascades	Collectively impassable	None	None
Dam Creek	Falls	10, 30	None	None
Cartright Creek	Falls	50	None	None
Ohanapecosh River	Hatchery dam	12	None	None
	8 falls	5 to 23	None	None

LITERATURE CITED

Craig, J. A. and Hacker, R. L.
1940 The history and development of the fisheries of the Columbia River. Bull. U. S. Bur. Fish., Vol. 49, No. 32, pp., 133-216., illus.

Davidson, F. A. and Wilding, J. L.
1943 A quantitative faunal investigation of a cold spring community. The American Midland Naturalist, Vol. 29, No. 1.

Lincoln, J. H. and Foster, R. F.
1943 Report on investigation of pollution in the lower Columbia River. Washington State Pollution Commission and the Oregon State Sanitary Authority. 143 pp. illus.

Rich, W. H.
1948 A survey of the Columbia River and its tributaries with special reference to the management of its fisheries resources. No. 1. Introduction. U. S. Fish and Wildlife Service Special Scientific Report No. 51. 26 pp. illus.

Washington State Pollution Control Commission
1945-1948 Progress Reports; Nos. 1-18

U. S. Geological Survey.
1930-1945 Surface water supply of the United States, Part 14, Pacific Slope Basins in Oregon and Lower Columbia River Basin. Yearly reports.

50082